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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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Royal Microscopical Society.

(Founded in 1839. Incorporated by Royal Charter in 1866.)

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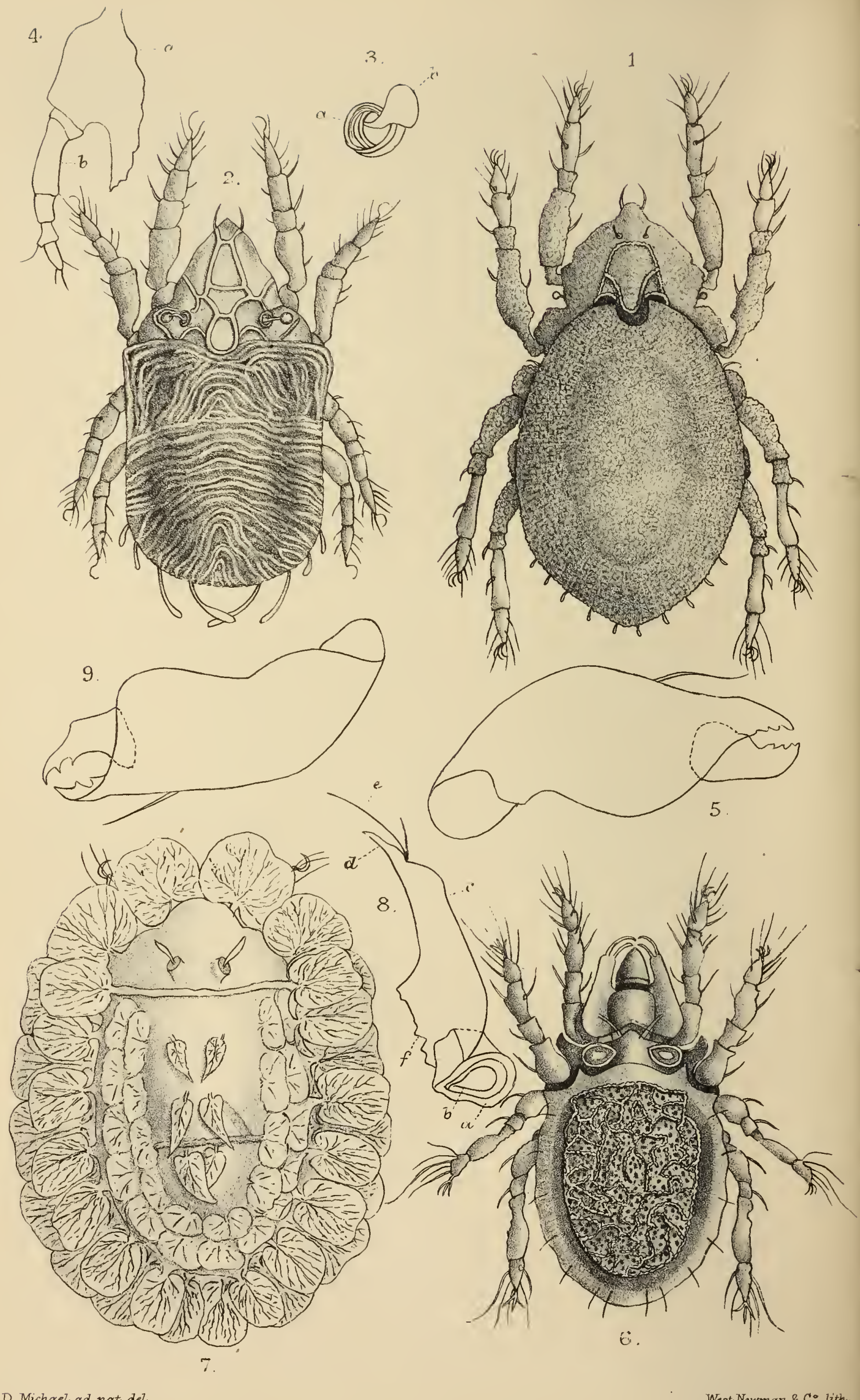

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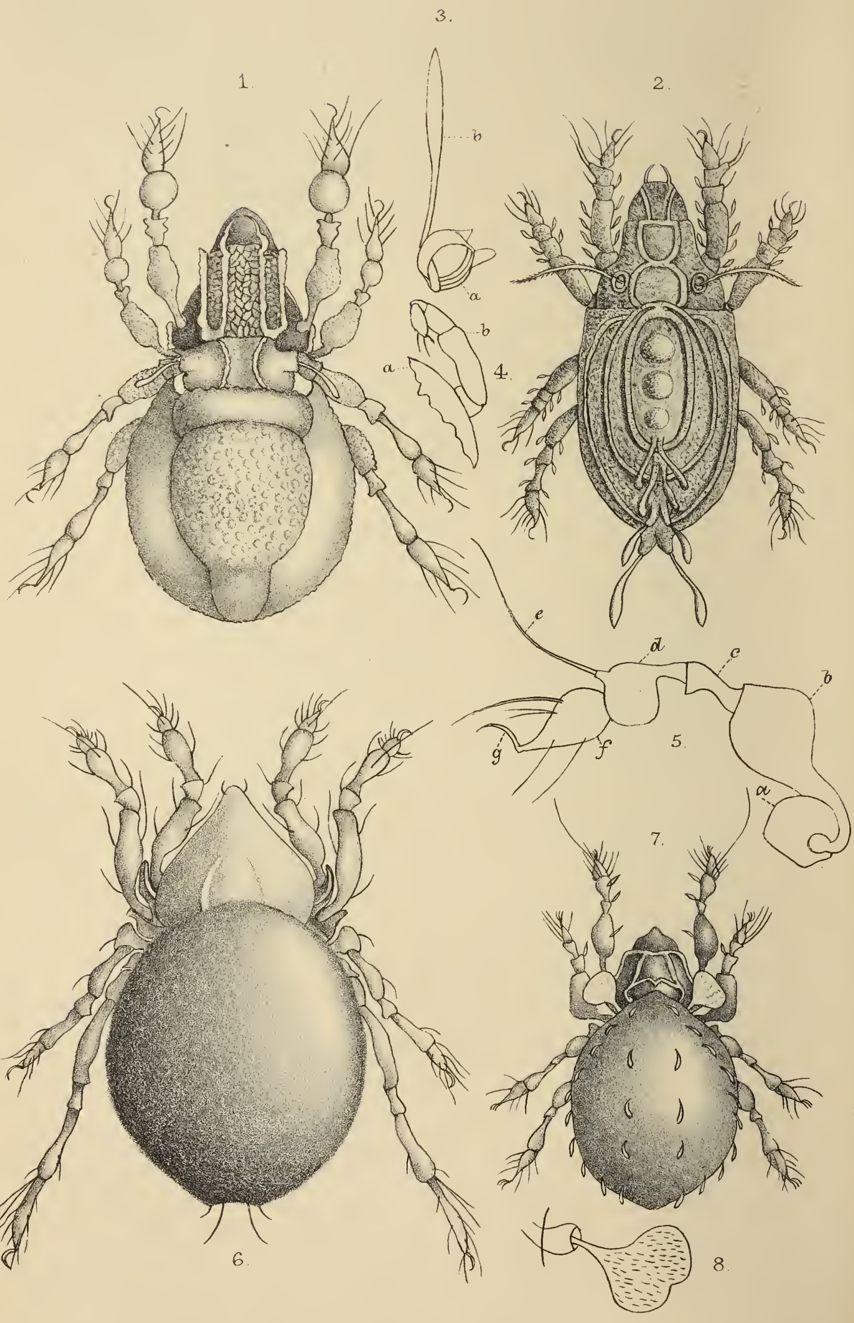

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1882.

TRANSACTIONS OF THE SOCIETY.

I.—*Further Notes on British Oribatidæ.*

By A. D. Michael, F.L.S., F.R.M.S.

(*Read* 14*th December*, 1881.)

Plates I. and II.

Since my last communication to this Society, I have continued my observations upon the life-histories, and general habits of the native species of *Oribatidæ*, and also my collection of these minute

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EXPLANATION OF PLATES I. and II.

Plate I.

Fig. 1.—*Scutovertex maculatus*, adult. × 100.
,, 2.—The same, nymph.
,, 3.—The same, adult; *a*, stigma; *b*, stigmatic organ. × 370.
,, 4.—The same, adult; *a*, portion of maxillary lip; *b*, palpus. × 370.
,, 5.—The same, adult; mandible. × 370.
,, 6.—*Cepheus ocellatus*, adult. × 80.
,, 7.—The same, nymph, nearly full grown; showing larval and two nymphal cast notogastral skins, the bordering scales of the existing skin not having yet passed far beyond those of the former skin.
,, 8.—The same, adult; *a*, stigma; *b*, stigmatic organ; *c*, wing of the tectum; *d*, terminal spine of same; *e*, hair set in at commencement of spine; *f*, portion of the tectum. × 170.
,, 9.—The same, adult; the mandible. × 370 (reversed).

Plate II.

Fig. 1.—*Damæus monilipes*, adult. × 160.
,, 2.—The same, nymph, full grown; showing the larval and two nymphal cast notogastral skins.
,, 3.—The same, adult; *a*, stigma; *b*, stigmatic organ. × 350.
,, 4.—The same, adult; *a*, portion of maxillary lip; *b*, palpus with 5th joint reflexed. × 450.
,, 5.—The same, adult, 1st leg; *a*, coxa; *b*, trochanter (so called); *c*, femur (so called); *d*, enlarged tibia; *e*, tactile hair on same; *f*, tarsus; *g*, monodactyle claw.
,, 6.—*Notaspis lacustris*, adult. × 105.
,, 7.—*Notaspis licnophorus*, adult. × 180.
,, 8.—The same, adult; *a*, stigma; *b*, stigmatic organ. × 570.

creatures, with a view to making our fauna more generally known. It is the experience of every one entering upon an almost untrodden path in natural history, or indeed in any other science, that at first new species and new facts accumulate rapidly and easily, while, after a time, novelties, whether of observation or of species, are more difficult to find and more laborious to follow out. I am not an exception to this rule, and naturally I cannot record the number of additions which I was able to make in my former papers. My searches have, however, been rewarded by finding species which I believe to be not only new to Britain, but entirely unrecorded anywhere, and which are far too numerous to be figured in the necessarily and properly limited number of plates which the kindness of this Society can place at my disposal. I do not think that written descriptions of creatures of this nature are of much real service without drawings, as, after all, words are but a vague way of identifying form upon which so much depends. I also think that drawings, to be of use to other naturalists, must be upon a sufficient scale to show detail, particularly with such organisms as the *Oribatidæ*, where specific distinctions depend greatly upon the formation of the essential parts of the cephalothorax, which in itself is frequently very small in proportion to the abdominal region. I have therefore thought it best, in this paper, to describe and figure a few of the more interesting unrecorded species with, I hope, some degree of exactitude, rather than to figure a larger number upon a scale which might possibly not be sufficient for identification hereafter.

Before proceeding to notice the unrecorded species, I will deal with such further observations as I can place before you relative to the habits, &c., of this family of *Acarina*.

Deposition or Protection of the Ova.

It will be found, by those who read works referring to this subject, that a great number of naturalists broadly state that the *Oribatidæ* are viviparous. I am not quite sure where the idea originated; some suppose that Claparède is responsible for it, but I fail to find anything in the writings of that excellent observer which in any way justifies the accusation. His only work treating of any of the *Oribatidæ*, as far as I am aware, is his chapter on the development of *Hoplophora contractilis* (as he calls it), in his 'Studien an Acariden,' and in this he expressly says that the idea is erroneous. It is not of much importance where the suggestion came from, but it is more worthy of remark that it has found its way into the works of some of the ablest and most accurate writers, who of course did not take it, or profess to take it, from their own observations, but simply on the authority of others; thus, for

instance, Huxley,* talking of the Acarina, says: "Most are oviparous, but the *Oribatidæ* are viviparous." This statement, in spite of the high authority for it, is certainly an error, although there may be a few exceptional instances of it, as will be seen later on in this paper, but those instances are, as far as I am aware, recorded here for the first time. The impression which has got abroad among naturalists, and held its ground so tenaciously, is, perhaps, the more curious, because Nicolet, the principal author who has written upon the *Oribatidæ*, says that the egg is deposited, and that the larva emerges very shortly afterwards, and this dictum of the French acarologist, in my opinion, correctly states what really occurs in a great many, and probably in the large majority of instances.

The result of my own observations has been to convince me that the matter is not quite so simple as naturalists have supposed, and that it is not possible to lay down one general rule which will be correct in all cases; indeed, this remark is applicable to most questions connected with *Acarina*. I have usually found that if I have attempted to generalize from a few known instances the rule which I thought I had found has broken down, and I have also found that a great number of the general laws enunciated by other observers fail to stand the test of a wider experience.

It seems to me that there are at least three if not four modes by which the eggs are brought to maturity, and the larvæ hatched, in different species, or under different circumstances.

The first method is that so well known in insects, that the egg is deposited in a fertilized but only slightly developed state. The long ovipositor, or extensile oviduct, of the female Acarid is used for this purpose, and the egg is placed in crevices of the wood, moss, or fungus, upon which the larva will feed; the egg adheres, either by a certain viscid quality in its exterior envelope, or more often is attached by a few threads of silk-like substance. Segmentation may have gone on in the egg to some extent before deposition, but very little progress has been made towards the differentiation of any individual parts of the future larva. A very considerable time often elapses between the deposition of the egg and the hatching of the larva in this mode, and I think that the creature probably often passes the winter in the egg state, and is only hatched on the approach of spring. I have frequently had the eggs myself for a long time before hatching in various species, as, for instance, *Damæus geniculatus*, *D. clavipes*, *Nothrus theleproctus*, &c.

The second mode is that which Nicolet apparently considered to be universal, and which I myself believe to be the most frequent, particularly in full summer. This is, that the development of the

* 'A Manual of the Anatomy of Invertebrated Animals.' London, 1877, p. 383.

egg is almost completed within the body of the living mother, and that the egg is extruded, certainly as an egg, as in the first method, but with the larva so fully developed that it escapes from the ovum very shortly after deposition.

I have a strong suspicion that a third mode, only to be found in exceptional instances, is that which Huxley states to be characteristic of the family, viz. that the female is viviparous or ovoviviparous. This, if it occur at all, is probably not the case at all seasons of the year, even in the species where it may take place during the period of most rapid reproduction. I have not any proof or certainty that this mode ever exists, for I have not ever witnessed the birth of a living larva, unenveloped in any egg-shell, from any of the *Oribatidæ*, but I have dissected out of the body of a female, either living, or killed immediately before, a larva, which, although not sufficiently strong or active to run, has been fully developed, and able to kick its legs and move its trophi in a very vigorous manner, and exhibit other signs of life. In addition to this, I have several times found larvæ in a cell where I had kept a pair of adults, and which I had carefully examined for ova a short time before without detecting any. I do not place much reliance upon this last reason, as the ova are sometimes extremely difficult to find in consequence of their smallness, their want of colour, and the places in which they are laid; but, as far as it goes, it is in favour of the occasional viviparous theory.

In the above-named three methods only one, or at the utmost two eggs are matured at one time; the reason for this is evident enough, as the egg is so large as to appear disproportionate to the size of the body, and many could not be ripe at once consistently with the life of the Acarid.

I believe that the fourth method has not hitherto been recorded by any observer, and it appears to me interesting. I have noticed it chiefly in the case of *Oribata globula*, but it probably exists in other species. It is as follows: The female, instead of maturing only one or two eggs at the same time, matures a much larger number, often a dozen or more, so that the abdomen appears to be entirely filled with them; these eggs are not laid, neither do they hatch within the body of the living mother, but the mother dies with the abdomen distended by fully formed eggs, in which the larvæ have not been developed. The whole contents of the abdomen except the eggs seem to dry up and disappear, leaving the chitinous shell of the parent as a protection to the ova. This condition of matters often lasts for a considerable time, indeed I believe that *Oribata globula* often, or usually, passes the winter in this state. When the larvæ are at length hatched, they escape by the opening of the camerostomum, the labium having probably dropped off, or by the genital or anal

opening, the folding doors which close these respective apertures having also dropped off. Sometimes the apertures are so small, or the larvæ so large, that they cannot easily escape by the apertures, and I have more than once had to assist those I had bred in confinement by breaking away the shell.

Dr. G. Haller, of Bern,* lately recorded the finding of numerous dried exo-skeletons of *Hoplophora* in winter among the fallen leaves, each shell having a large single mature egg in it. Haller concludes that the female *Hoplophora*, when about to deposit an egg, seeks for the exo-skeleton of some deceased member of its own species, and uses it as a shelter for the egg. It is of course quite possible that this may be so—I cannot deny it—but, as Haller does not appear to have seen the egg laid, and he was hardly likely to have done so, as the *Oribatidæ* object to light, I cannot help thinking that this is probably another instance of the fourth method above described, with the distinction that here only one egg is matured at once. If it be not so, it is odd that the *Hoplophora* should always choose the exo-skeleton of a *Hoplophora* instead of distributing its favours more generally amongst other genera.

Deutovum Stage.

Another observation which I have to record, is relative to the development of the egg after extrusion. The eggs of some *Oribatidæ* are of a rather leathery consistency, those of other species are provided with a hard chitinous shell, which is brittle and non-elastic. Claparède, in his 'Studien an Acariden,' records the occurrence, in the ova of *Atax bonzii*, of what he calls a deutovum stage; Megnin has observed a similar thing in the case of *Trombidium fuliginosum*, and I myself noticed it in the ova of other *Trombidiidæ*, but I am not aware of any one having observed it amongst the *Oribatidæ*. I have now to record that it decidedly is equally a portion of the life-history of some, but not of all, members of this family. The deutovum stage is as follows: When the exterior shell of the egg is hard and non-extensile, the gradual increase of volume in the egg-contents produces so much pressure from within upon the shell that the latter splits sharply all round its periphery, dividing it into two somewhat boat-shaped halves; the inner membrane which lines the shell has in the meantime increased in strength, and has become the true envelope. The space between the two broken halves of the exterior shell is at first a mere line, but, as the contents increase, this line widens, and the halves of the old shell get pushed further and further apart, showing a broad white space (the inner membrane)

* "Miscellanea acarinologica," MT. d. Schweiz. entom. Gesellschaft, 1879, No. 4, p. 502.

between them. It is along this line that the rupture takes place when the larva escapes, as recorded in my first paper on the *Oribatidæ* in this Journal.*

Wood-boring Species.

Claparède, in his 'Studien an Acariden,' records the result of his excellent observations on *Hoplophora* in its immature stages, his discovery that the larvæ and nymphs were wood-boring creatures, and he expresses his astonishment at finding that the nymphs and larvæ were soft white creatures, when the adults are so hard and dark; he calls it passing through an Acarus stage. I find that *Hoplophora* is not by any means an exceptional instance in either of these particulars. The nymphs of *Hermannia arrecta, Tegeocranus elongatus, Cepheus vulgaris,* and some others, live in dead wood, which they perforate with long burrows in all directions, until the wood is often thoroughly riddled by them, only the thinnest partition being left between the burrows. The larva or nymph, as the case may be, is usually found at the end of the burrow furthest from the mouth, being in fact the last place which it has worked to; the burrow behind it is usually filled with excremental matters and wood-dust. The nymph of *Tegeocranus coriaceus* burrows into the more solid fungi in exactly the same manner, and there are doubtless other boring species which I have not yet traced. It is rather interesting to observe that, in all of these instances, the larvæ, or nymphs, are soft, white creatures, entirely without the defensive armour or other protection possessed by members of the family which are more exposed to danger than these sub-cortical species.

Ecdyses of Leiosoma palmicinctum.

Those who have seen the beautiful nymph of *Leiosoma palmicinctum,* which is figured in a former paper of mine in this Journal,† will not readily forget it. I was curious to see how the very large Japanese-fan-shaped, membraneous hairs, which form a broad border round the abdomen of the nymph of this species, were disposed of during the formation or ecdysis. I had naturally imagined that they would be folded up, either by closing the nervures together like a fan, or else transversely like the wings, &c., of insects. The extremely simple and pretty method by which nature effects the packing did not strike me. The elegant membraneous hairs grow on the edge of the body, and are formed fully expanded; instead of being doubled up, their peduncles are simply turned down a little, so that the palmate hairs lie flat against the ventral surface of the Acarid, and are thus protected from injury;

* Vol. II. (1879) p. 225. † Vol. III. (1880) Pl. III.

the two pairs of immensely long setiform hairs, which spring from the edge of the abdomen, are also bent down upon the ventral surface, instead of being folded, and there form a diagonal cross. The whole arrangement may be most distinctly seen through the existing skin, pending one of what, for want of a better name, I call the inter-nymphal ecdysis, i. e. a change of skin which does not take place upon any transformation, but simply upon the nymph growing larger. I have luckily succeeded in mounting a specimen in this condition which shows the whole arrangement admirably. I have not figured it from want of space.

New Species.

Among the unrecorded species described and figured below are one or two which may be worthy of some remark, although I have not any very striking novelty to record this time.

In my paper published in the third volume of this Journal, page 186, at the end of the description of the nymph of *Leiosoma palmicinctum*, I stated that I had brought home what I had supposed to be several very young specimens of that nymph found upon the golden lichens growing upon the rocks of the Land's End, but that, when examined with a higher power, they turned out to be a different species, the shape being slightly longer, and the nervures of the palmate hairs irregularly furcate instead of reticulated. I also stated that they had not attained the adult condition, and that I doubted their surviving the winter; that doubt became considerably stronger as the winter advanced, for my captives became to all appearance dead, and I feared that the only thing to be done with them was to mount them as specimens. I was still unwilling to abandon a hope, however remote, of tracing the species, and my patience was in this case rewarded, for, as the spring advanced, the apparently dead nymphs began to move about very slowly, and finally underwent their last transformation, and there emerged an adult, which was new to me, and I believe unrecorded, and which was moreover quite distinct from anything I had seen, and was a handsome species. The interesting part was, however, that, although the two nymphs resembled each other so closely that it required a careful examination with a moderately high power to find out the difference, and although they were utterly different from all other known nymphs, and notwithstanding that they came from the same place and both fed upon lichen, yet the imagos were quite dissimilar, and not in any way to be included even in the same genus. *Palmicinctum* is a *Leiosoma*, and the present species, although it does not fit very well into either of Nicolet's genera, yet is certainly a *Cepheus*, unless a new genus were made for it, which does not seem to me to

be desirable. I have called it *ocellatus* from the curious effect, like two great eyes, produced by the globular stigmatic organs (or protecting hairs as Nicolet calls them) being sunk exactly in the mouths of the stigmata. This is the only instance of such an arrangement which I am aware of in the *Oribatidæ.*

Another somewhat singular creature is the very minute being which I propose to call *Notaspis licnophorus:* here again the peculiarity is in the stigmatic organs, which are flattened, and so large as to appear quite disproportioned to the Acarid. When I have had this tiny creature alive on the stage of the Microscope for the purpose of observing or drawing it, I have seen the stigmatic organs blown about by the wind.

A third very curious new species is the one I propose to call *Damæus monilipes:* the remarkable part of this creature is the form of the legs, particularly the first pair, where the tibia is a globular mass which appears altogether too large for the Arachnid, and gives it the effect of carrying a mace on each side.

A fourth curious species I propose to call *Notaspis lacustris:* the peculiarity is its being strictly aquatic, and being often found covered with diatoms.

In conclusion I may briefly allude to certain slides which have been in circulation of late as being mounts of an *Acarus* supposed to feed upon the *Phylloxera;* those that I have seen have been a collection of various *Acarina,* of different families—in fact anything and everthing found upon a vine; amongst them were more than one of the *Oribatidæ.* I think that such information should be received with extreme caution, as I am not aware of any well-authenticated instance of any species, which really belongs to this family, being habitually predatory.

Descriptions of Species.

Cepheus ocellatus *n. sp.* Pl. I. Figs. 6–9.

Average length about ·6 mm.
„ breadth „ ·32 mm.
„ length of legs 1st, 2nd, and 3rd pairs about ·24 mm.
„ „ „ 4th pair about ·32 mm.

This species does not fit very happily into any of Nicolet's genera, but I do not think it is desirable, at present, to create a new genus for it. The only one of the existing genera in which it can be included is *Cepheus,* and in that genus I accordingly place it provisionally.

It is a somewhat singular, and very well marked species. The *colour* is very dark brown, often almost black, and the texture is dull, without the slightest gloss.

The cephalothorax is rather more than a third of the total

length, broad, and flat. The rostrum blunt, the tectum large and well marked, its wings (or lamellæ) very large, nearly on edge, and projecting far beyond the anterior edge of the horizontal surface of the tectum; at their anterior termination these lamellæ are truncated and slightly rounded, from the lower angle of the truncated edge springs a stout spine, which curves forward and downward, and almost touches the tip of the rostrum. A little above this spine, on the same truncated edge, is a much thinner but rather longer spine, or hair, almost parallel to the thicker one. Each lamella increases in width as it nears the abdomen, and terminates suddenly, with a rounded shoulder, just in front of the stigma. The stigmata are placed at the junction of the cephalothorax and abdomen, they are very large and open: the opening faces straight upward. The stigmatic organs (or hairs) are globular, and are sunk in the mouth of the stigmata, which gives each stigma the appearance of being an enormous eye—it is from this effect that I have named the species. This peculiarity alone would be sufficient to distinguish the present species at a glance from every other which I am acquainted with. The interstigmatic hairs are short spines just inside the stigmata. The palpi are subcylindrical, with the first joint much the longest, the third and fourth very short, the fifth conical and densely haired, labium longer than broad, mandibles very small.

The *legs* are stout, all joints except the tarsi very rough and irregular in outline, the second joints much the thickest, the tarsi short and stout. The first two pairs reach considerably beyond the rostrum, the fourth pair only slightly beyond the posterior margin. The tarsi are clothed with numerous very thick hairs, the other joints have very few hairs on them.

The abdomen is oval, truncated anteriorly, with the antero-lateral angle produced so as to form short points projecting forward and almost touching the stigmata. There is a broad flattened margin, somewhat raised towards the edge, all round the abdomen, except where it joins the cephalothorax; this band bears a row of blunt spines, not quite regularly arranged; inside the band the notogaster is arched, but not very strongly; it is divided by ridges into irregular strips or bands, of which one or two run nearly parallel to the anterior margin and the rest run more or less longitudinally. There are usually about ten bands in the width; each band contains two rows of round pits, the position of the pits being alternate, i. e. the pits in one row come between, and not opposite to, the pits in the adjoining row. The anal plates are very large, and the genital plates are close to them; both sets are sub-oblong in form.

The Nymph.

This is so similar to the nymph of *Leiosoma palmicinctum* * that I think it will be convenient to point out the differences rather than to describe the whole creature again. The present species is a rather longer and narrower elliptical form than *palmicinctum*. The beautiful expanded membraneous hairs, each shaped like a Japanese fan, which form a broad border all round the creature in both species, are similarly arranged along the lateral and posterior margins of the abdomen in both species, but in *palmicinctum* they also run round the anterior margin, entirely covering up the cephalothorax. In the present species they are absent from the anterior margin of the abdomen, but they complete the elliptical border of hairs by running round the margin of the cephalothorax itself, and a similar hair on each leg of the first pair completes the border below the rostrum. This hair is absent in the nymph of *palmicinctum*, but is present in the larva of that species. The result of this arrangement is that the cast notogastral skins borne on the back of the nymph have not any expanded hairs along their anterior margins, *palmicinctum* has. There are three pairs of similar hairs, but longer and more pointed in form, down the centre of the notogaster, being in fact upon the notogastral portion of the cast larval skin. Another very leading distinction between the two species is that in *palmicinctum* the nervures of the expanded membraneous hairs are reticulated, whereas in *ocellatus* they are irregularly branched.

The stigmata and stigmatic hairs (or organs), which are hidden in *palmicinctum*, are present and conspicuous in *ocellatus*; the organs are somewhat lancet-shaped. Another great difference is the entire absence in the present nymph of the four immensely long hairs which project round *palmicinctum*.

In other respects than those above named the same description would serve for both species, although the adults are so different.

I have only found the species upon the yellow lichens which clothe the granite rocks of the Land's End, Cornwall; it is not common even there.

NOTASPIS LICNOPHORUS,† *n. sp.* Pl. II. Figs. 7, 8.

Average length about ·19 mm.
„ breadth „ ·11 „
„ length of legs, 1st and 4th pairs, about ·1 mm.
„ „ 2nd „ 3rd „ „ ·08 „

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* Described in this Journal, iii. (1880), p. 184.
† Λικνον, a fan; φερω, I bear.

This extremely minute species is principally distinguished by the disproportionately large size and unusual shape of the stigmatic organs, from which I have named it.

The *colour* is light yellow-brown, and the whole dorsal surface is highly polished.

The *cephalothorax* is considerably narrower than the greatest width of the abdomen, but at the actual point of juncture the cephalothorax is slightly the wider, and is partially hidden by the advancing anterior point of the latter. There is a small central point to the rostrum, which then has a very obtuse angle, and, after attaining nearly its full width, becomes more parallel-sided. The cephalothorax widens suddenly at the anterior edge of the tectum, which projects beyond the lateral margin of the rostrum. The central portion, or tectum proper, although attached to the cephalothorax by its whole surface, has the position of the lamellæ marked by two strong ridges joined by a transverse ridge anteriorly, and also joined posteriorly, not far from the abdomen, by another ridge, not straight, but forming three angles, the central pointing backward, and the two lateral ones pointing forward; after these join the ridges which represent the lamellæ, the two united ridges turn sharply inward to escape, and border, the inside of the stigmatic elevation. *The stigmatic organs are of moderate length, very broad, and flattened out, and resemble the Japanese or Indian fans,* only that the distal margin is slightly undulated; these organs are marked with lines of elevated dots, and from their large surface they are blown about a little by the wind.

The legs are of moderate length, the second joints very thin at their insertion, but suddenly, and much enlarged, narrowing again somewhat at the distal end; the third joints very small and fine; the tibiæ wineglass-shaped, much enlarged at the distal margin; the tarsi short and stout, *the triple claws very heterodactyle.* This latter point, according to Nicolet's definition, would prevent the creature being included in the genus *Notaspis.* The tibiæ of the first pair of legs have the tactile hair long, the tarsi have numerous fine hairs, and there are one or two short spatulate hairs on each of the other joints of each leg.

The *abdomen* is elliptical, pointed anteriorly and posteriorly, the anterior point being the sharpest. There is a close row of short, curved spatulate hairs round the margin, and two longitudinal rows of about three similar hairs near the centre of the notogaster.

I have found the creature in decayed wood at Tamworth, in Warwickshire, and at Epping Forest; it is not common. I believe it to be unrecorded.

Nymph.

The nymph of this species so closely resembles the perfect form that I do not think any one would mistake it. I therefore have not figured it, and only give here the differences from the perfect form (beyond the ordinary one of being monodactyle instead of tridactyle).

The *colour* of the nymph is pure milky white, without a speck of darker marking about it.

The general thickness of the legs is greater in the nymph, and the shapes of the respective joints are not so varied.

The markings figured upon the cephalothorax of the adult are not found on the nymph.

The hairs bordering the abdomen are rather smaller in the nymph than in the adult.

The skin is covered with slight wrinkles or vermiform markings instead of being polished.

NOTASPIS LACUSTRIS, *n. sp.* Pl. II. Fig. 6.

Average	length about	·5 mm.	
„	breadth „	·33 „	
„	length of legs, 1st pair, about	·26 mm.	
„	„ 4th „ „	·40 „	

I have ventured to include this species in the genus *Notaspis*, although this is a monodactyle species, and Nicolet defines the genus as tridactyle; but I have come to the conclusion that, although it was perfectly natural for Nicolet, working from the species he was acquainted with, to take the number of claws as distinctive of genus, yet there are some genera in which this cannot be supported as a good characteristic.

This species is strictly aquatic, but is not a swimming creature; indeed, none of the *Oribatidæ* are. It crawls about the subaqueous plants, and is confined to fresh water. It is often found covered with diatomaceæ, which adhere to it sufficiently tightly to be preserved upon it.

The *colour* is dull reddish-brown; the texture is smooth but not polished.

The *cephalothorax* is less than half the length of the abdomen, and forms a broad, short cone, with a slightly rounded apex; it is considerably rounded at the posterior angles. The base is almost as wide as the anterior margin of the abdomen. There are not any markings on the dorsal surface, except two short ridges, which are doubtless the homologues of the wings of a tectum, but otherwise that part is absent. The stigmatic organs are not visible, and there are not any interstigmatic hairs; the rostral hairs are short and curved.

The *legs* of the first two pairs are set in deep clefts of the projecting lateral portions of the sternum; they have a tendency to set outward. The second and fourth are the principal joints, the tarsi being short and thick. Each tibia bears a long tactile hair; the tarsi have numerous fine hairs, and the other joints, except the coxæ, mostly have a few longish, fine hairs, chiefly arranged in whorls.

The abdomen is a short ellipse, not far from a circle, and is very slightly truncated posteriorly. This truncated portion bears two pairs of short, fine hairs, the inner pair being the longest.

I believe I know the nymph of the species, but as I have not actually bred it I refrain from describing it.

The species is common and generally distributed.

Scutovertex maculatus,* *n. sp.* Pl. I. Figs. 1–5.

Average length about ·54 mm.
„ breadth „ ·30 „
„ length of legs, 1st and 4th pairs, about ·33 mm.
„ „ 2nd „ 3rd „ „ ·30 „

The *colour* both of body and legs is dark brown, almost black; the whole dorsal surface is thickly sprinkled with raised dots. These are irregular in shape, and in scattering on the cephalothorax, but on the abdomen, which constitutes by far the larger portion of the creature, they are more even in size and arrangement, being closely packed, and more or less approaching round or subsquare. Towards the lateral and hind margins of the abdomen these dots form lines of dots radiating from the centre of the body, along the front margin they are transverse in arrangement, and in the centre they are irregular, or form labyrinthine lines. These dots projecting make the edge, or any part seen against the light, always appear rough.

The shape of the creature is an elongated ellipse, being nearly twice as long as broad.

The *cephalothorax* is broad and rather large, but is greatly overhung by the anterior margin of the abdomen, which hides a large part of it. The extreme tip of the rostrum is small and rounded, and bears a pair of hairs. From thence the cephalothorax widens suddenly, and becomes much arched, and again widens somewhat suddenly at the insertion of the first pair of legs. There is a tectum very conspicuous, but short and narrow, and without lateral wings, or rather the edges are thickened, slightly raised, and then turned downward, giving an appearance of being attached to the cephalothorax by their whole circumference.

From about the middle of the internal edge of the lateral ridge

* *Maculatus*, spotted.

of the tectum, on each side, another ridge starts and runs backward at an angle, so that the two together form a V-shaped marking, the point of which is rounded, and lies within an indented semicircle in the anterior margin of the abdomen. The elevated markings on the tectum form transverse wavy lines. There is a strong chitinous projection from the side of the cephalothorax between the second and third pairs of legs. The stigmata are near the lateral margin between the first and second pairs of legs. The stigmatic hairs are short, and consist of a small globular head, on a stout filiform peduncle. There are two pairs of short, thick hairs on the dorsal surface of the cephalothorax.

The coxæ of the first two pairs of legs are hidden beneath the body. The trochanters of the same pairs are large and long, but suddenly become small, and turn almost at right angles near their insertion into the coxæ. The coxæ of the third and fourth pairs of legs are rounded and conspicuous. The second and fourth joints are the longest in all the legs, the third joint being the smallest. The first three joints in each leg are covered with irregular raised markings. The tarsi have a few fine hairs round the claws, which are very heterodactyle. There are three short, thick hairs on the fourth joint of each leg of the first two pairs, and a few other similar hairs on the different joints of the legs. All these hairs are very caducous.

The abdomen is elliptical, slightly pointed posteriorly, and slightly truncated anteriorly; it is indented between the insertion of the third pair of legs and the stigma, and the anterior margin is cut out in rather more than a semicircle. This indentation receives the point of the V-shaped ridge on the cephalothorax; and at the side of it the anterior margin of the abdomen is attached to the upper surface of the tectum. There are about ten short, thick hairs round the hind margin of the abdomen, also very caducous.

On the ventral surface the genital plates form almost a square, and are far forward. The anal plates are large, elliptical, and touch the posterior margin.

Nymph.

The *colour* of this curious nymph is dull opaque brown, often with a shade of dark olive green in the brown. It is so broad and flat in general shape as to give the effect of having been flattened out, and it is thickly covered with wrinkles and ridges all over.

The *cephalothorax* is flat, long in proportion to the abdomen, but not in proportion to its breadth, conical, but sharply excavated at the edge, for the insertion of the first pair of legs. The base of the cephalothorax is narrower than the anterior margin of the abdomen, and the second pair of legs are inserted in the angles thus

formed. The cephalothorax bears a complicated series of ridges not easy to describe, and which will be best understood by reference to the drawing. I will, however, endeavour to give an idea of their arrangement in words. The median (or axial) portion of the vertex is divided into three spaces bordered by strong raised ridges. The anterior one is trapeze-shaped, with the small end foremost and coming near to the point of the rostrum, but not reaching it. Two short ridges, however, run from the anterior angles of the trapeze, one to each side of the rostrum, very near to the point. The ridge which forms the posterior border of the trapeze forms the anterior border of a hexagon, which has curved sides, convex inwards, the anterior side being the longest, and the two next sides very short. The posterior ridge of the hexagon forms the anterior margin of an oblong or elliptical figure, usually somewhat constricted in the middle. This figure extends back on to the abdomen, so that it is difficult to say where the abdomen commences in the median line. From the central angle on each side of the hexagon a short transverse ridge runs about half-way towards the lateral margin. From its termination a ridge runs forward to the front of the excavation for the first leg, and another, or continuation of the same, runs back to a circular ridge surrounding the stigma, and from the stigma a triangular space bordered by another ridge extends to the lateral margin. The stigmatic organs are short, globular, on a short peduncle, and very white. The interstigmatic hairs are absent or little seen; the rostral hairs are present.

The *legs* are stout and gradually diminished towards the end. The third and fourth joints of the two front pairs each bear a strong serrated spine on the upper side; the other hairs on the legs are short, and the tactile hair is absent.

The abdomen is flat in general effect, but has somewhat raised anterior and lateral edges, and is raised to about the same extent along the median portion, being slightly arched there; between this median portion and the lateral edge is a depressed channel. The whole abdomen is covered with wavy closely-set irregular wrinkles. Three or four of these run along the anterior, and about half-way down the lateral margin; the centre of the space enclosed by these last-named wrinkles is occupied by a set of wrinkles bending strongly forward. Behind them the wrinkles become more transverse, until near the posterior margin, where they again bend strongly forward. The posterior margin is set with eight spatulate hairs, of which the two lateral pairs are very short, the two central pairs much longer and directed inward, the central pair crossing.

I have only found the species on the lichen near the sea-shore, at the Land's End, Cornwall. It has not to my knowledge been recorded before I found it, and it is not common.

Damæus monilipes, *n. sp.* Pl. II. Figs. 1–5.

Average length about ·34 mm.
„ breadth „ ·18 „
„ length of legs, 1st pair, about ·17 mm.
„ „ 2nd and 3rd pairs, about ·15 mm.
„ „ 4th pair, about ·19 mm.

This is an extremely minute but rather elaborately formed species. I have included it provisionally in the genus *Damæus*, but that genus will probably require division—perhaps by reviving Koch's genus *Oppia*, and properly defining it, in which case the present might well serve for a type-species. The *colour* is rather light brown, and has a whitish shade over some of the raised parts. It is not very strongly chitinized, and is indeed rather more leathery in texture than most of the family, except the genus *Nothrus*, and, like many other *Oribatidæ* which have this texture, and are thus not as fully protected as harder species, it makes up for the deficiency by covering itself with dirt to such an extent that it is almost impossible to get it clean, its very small size being an additional difficulty. The figure and this description are taken from a carefully cleaned specimen, otherwise many of the details would not be seen. Another source of error, which must be avoided in identifying the species, is that the elevations on the dorsum of the abdomen are apt to lose their form and be very difficult to see shortly after death, particularly if treated with reagents. By care, however, the true form may be preserved.

The division between the cephalothorax and abdomen is very marked. The actual rostrum is short and conical, not a third of the length of the dorsum of the cephalothorax. Behind this the cephalothorax is covered by a tectum or its homologue, but the whole of it is anchylosed to the surface of the cephalothorax, and does not stand free. The lateral edges are straight or slightly concave, but very rough. The anterior edge is rather convex; the wings of the tectum are well marked, and are also anchylosed to the surface of the cephalothorax; they are reflexed, sloping downwards on the side of the cephalothorax. A strong ridge runs along the juncture of each wing with the tectum, and this ridge projects forward beyond the edge of the tectum, forming a strong, rough, curved point, terminated by a hair; indeed, it seems to have taken the place of the projection frequently found at the anterior edge of the wing. The whole tectum is reticulated, but the reticulations are not easily seen on the wings. Behind the juncture of the tectum the cephalothorax rises suddenly, and forms a rough central lump, at the edges of which are the stigmatic tubes projecting to an unusual degree, the stigmata opening at the extreme edge of the body. The stigmatic organs (or hairs) are long, spatulate, rough, and point upward, outward, and backward.

There is a deep depression between the hinder part of the cephalothorax and the abdomen.

The legs are very remarkable, or at least the first pair is. They are by no means so long as is usual in the genus *Damæus*, and the forms of the pieces are singular. The coxæ are not visible from the dorsal aspect, and the expansion of the cephalothorax above mentioned has a deep cleft to admit the upward motion of the thin proximal end of the so-called trochanters of the first pair of legs. This joint is greatly enlarged. The first two pairs of legs have the so-called femurs very short, with a short, thin, proximal, and a much broader, almost square, distal end. The tibiæ of the first pair of legs are the pieces which render the legs exceptional; they are globes which appear disproportionately large, and are borne on extremely short and very thin proximal ends. The tarsi are all pyriform, and thickly clothed with hairs. The enlarged tibia bears a long tactile hair.

The abdomen is elliptical, slightly pointed posteriorly, and strongly truncated in front; its antero-lateral angles are produced into well-marked points, which curve towards the stigmata, so that from the dorsal aspect two open spaces are seen, bounded on the outside by these points, and anteriorly by the coxæ of the third pair of legs. Immediately behind the anterior margin there is a broad, rounded, transverse elevation, not reaching the lateral margin. Behind this is a deep, linear depression, and then the centre of the abdomen, until within a quarter of its length from the hind margin, is occupied by a domed lump, followed by a smaller one, which touches the hind margin. Exterior to these elevations the abdomen is a broad, almost flat, expansion, which seems to form a flat annulus round the central elevation. At the extreme edge of this is a narrow, rough ridge. The annulus curves downward towards the margin, but not very strongly. The whole surface of the abdomen is rough and irregularly sprinkled with raised dots, which are far largest and most conspicuous on the central lump.

The Nymph.

This is also rather a complicated creature, not very easy to describe. The *colour* is light oak-brown, with a tendency to a grey dusty effect over the raised parts of the skin. The texture is a little like fine shagreen, and the general outline is a shield-shaped abdomen surmounted by a bluntly conical cephalothorax.

The *cephalothorax* is rather more than one-third of the whole length; at its base it is nearly as wide as the abdomen. The rostrum is rounded anteriorly, and slightly truncated. A blunt point on each side of the truncation carries the curved rostral hair. The cephalothorax appears arranged in three spaces, which, com-

mencing anteriorly, are, first, the rostrum, which bears two longitudinal ridges commencing close to the above-named points, but sometimes a trifle nearer the lateral margin; the second division extends from the rostrum to the insertion of the first pair of legs, and has a central shield-shaped space on the dorsal surface, enclosed by a raised ridge, against the front of which the ends of the before-named longitudinal ridges abut. A smaller space, narrower in proportion, on the slope of each side, is also enclosed by a ridge. The third portion of the cephalothorax extends to the abdomen, and has a central octagonal space enclosed by a similar ridge, abutting on the shield-shaped ridge anteriorly, and on the abdomen posteriorly. On each side of the octagon is a rounded, somewhat mamillar portion, bearing the stigma, which is dorsal. The stigmatic organs (or hairs) are long, filiform, rough, and sinuous. The interstigmatic hairs are apparently absent.

The *legs* are rather short, of almost even thickness throughout, rough, and with a projecting point on the front tibiæ, which bears a very strong tactile hair. The other joints each have a pair of short, curved, spatulate hairs. The tarsi are short and thick, and clothed with numerous fine hairs.

The *abdomen* carries the cast notogastral skins stretched quite flat on the back, except that the edges of each skin have curled up and form ridges, thus, in the full-grown nymph there are three almost concentric ridges. Within the space enclosed by the inner ridge—i. e. upon the larval skin—are three hemispherical knobs, arranged longitudinally. There are two projecting points at the posterior end of the creature, and of each cast skin, and each point bears a long, spatulate, curved hair.

The creature lives in decayed wood. I first found it in some material brought from Yorkshire by the Rev. H. Tattershall, and I have since found it myself in Hopwas Wood, near Tamworth.

II.—*A New Growing or Circulation Slide.*

By T. Charters White, M.R.C.S., F.R.M.S.

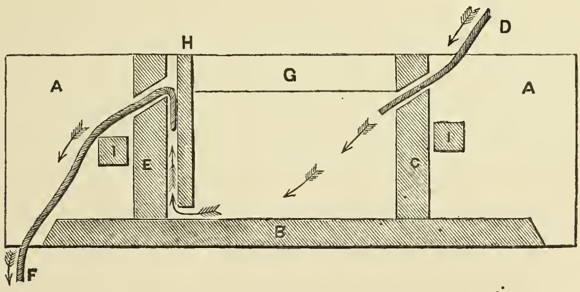
(*Read* 14*th December*, 1881.)

Increasing attention has of late years been devoted to the subject of slides by which the development of microscopical organisms can be observed, but the majority of the forms suggested have been attended by various drawbacks and disadvantages in their design and construction, leading to their disuse. The one here described seems to be as efficient as can be desired; it is, however, merely put forward as a suggestion, and I do not venture to claim for it more than simplicity and efficacy to recommend it to microscopical observers.

It often happens that in examining a gathering from some aquatic source an organism is met with about which the observer would desire to know more, but to transfer it from his slide to one of the growing slides in ordinary use would probably result in its loss or destruction. The slide now described is designed to supersede the use of the glass slip generally used for this examination, so that should such an organism present itself all that is required to maintain a constant current is the insertion of threads of cotton into openings in the sides of the cell. The organism is then duly nourished, and no alteration occurs to interfere with its proper development, which can be readily noted from time to time.

The slide (Fig. 1) consists of the usual glass slip A A (3 in. × 1 in.), having a narrow ledge of glass B (about $\frac{1}{8}$ inch

Fig. 1.



wide, and extending nearly its whole length), cemented to its lower border with marine glue; to this is cemented at right angles a strip of thin covering glass C, about $\frac{1}{4}$ inch wide and about $1\frac{1}{8}$ inch from the end of the slide, having a narrow channel cut through it for the passage of an intake thread D. A similar strip

E, having a like cut through it for the passage of an outlet thread F, is cemented at the same distance from the opposite end of the slide. In this condition the slide being filled with water to the level of G, any current coming in through the intake thread D would pass directly across the top of the water in the cell, and pass out by the outlet thread F, and organisms near the bottom of the cell would not be benefited by a change of water; I therefore cement a very narrow slip H of the same covering glass as before to the inner side of the outlet end of the cell, commencing at the top of the slide, and extending to very nearly the bottom, so as to leave about $\frac{1}{16}$ inch between E and H. If the intake thread is connected with a bottle of water placed above the level of the slide, water entering by the intake thread will pass in a diagonal direction from D to the left and bottom of the cell, where the influence of the suction set up by the siphon-like action of the outlet thread makes itself felt, and there is a regular current in the direction of the arrows.

The front of the cell is formed of a piece of thin covering glass of $1\frac{1}{2}$ inch by $\frac{5}{8}$, and two small square blocks of glass I, cemented on each side, will hold this covering glass sufficiently firm to prevent it sliding on the organism and crushing it.

Such a growing slide will hold about 1 drachm of water, and taking the rate of the drops from the outlet thread as about one per minute, the whole of the water in the cell is changed once in an hour, while at the same time the current is not sufficiently strong to carry away more than the finest and lightest bodies. It allows of fair observation with a $\frac{1}{4}$-inch objective, and if desired could be made with thinner glass, so that a $\frac{1}{6}$-inch or $\frac{1}{8}$-inch might be used.

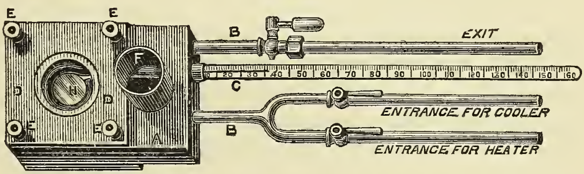
III.—*On a Hot or Cold Stage for the Microscope.*

By W. H. Symons, F.R.M.S., F.C.S.

(*Read* 14*th December*, 1881.)

This stage consists essentially of a copper or brass box A, Fig. 2, 8 cm. long, 5 cm. broad, and 1·5 cm. deep; an open tube F, 5 × 2 cm., communicates with the interior, and allows of the expansion of the contents and for filling. In the upper and lower sides of the box are apertures H, for the passage of light, 2 cm. in diameter, the lower covered by a thin glass cover, 2·5 cm. in diameter, and the upper by one which constitutes the working stage, 3·5 cm. in diameter. Both covers are kept in position

Fig. 2.



between pairs of vulcanized rubber rings by means of brass plates D, clamped on with screws E, the plates being furnished with apertures slightly smaller than the thin covers. A thin copper pipe B B, 5 mm. in diameter, is carried round the bottom of the inside of the box A, one end being forked, and all three branches furnished with taps. This pipe serves to convey the heating or cooling agent to the water or other liquid contained in the box.

The temperature is ascertained by means of a thermometer C, having its bulb bent in a circle slightly smaller than the aperture for light; it is placed in the box with the bulb almost touching the upper thin glass cover. Between the thermometer and the copper pipe is a copper partition, having a number of slots in its base to allow of the circulation of the water. In this way the thermometer is protected from undue heat, and as all water which reaches the upper thin glass must pass it, a very near approximation to the temperature of the object upon the thin glass is obtained, especially if the object is protected from currents of air by a cardboard shade.

The most convenient heating agent is steam, a small flask 100 c.c. capacity will work for over an hour, and the temperature may be varied from normal to 95° C. at pleasure; steam, however, gives out its latent heat immediately on coming in contact with the tube, and therefore that portion of the box or bath nearest to the supply becomes warm very much sooner than that further

from it; if great exactness be required steam can be replaced by a current of warm water or saturated solution of chloride of calcium, which give out only specific heat, and that nearly equally through the whole length of the tube. In either case the box is filled with recently boiled distilled water or a saline solution, and placed, with a non-conductor intervening, upon the stage of the Microscope, so that the optic axis corresponds with the centres of the apertures; one of the forked tubes is then connected with the hot fluid, the other with a supply of ice-cold water, and the exit end of the copper tube with an empty vessel. The object is now placed upon the thin glass stage, covered with another thin glass, and surrounded with a cardboard shade and focussed. The heating agent is circulated through the copper pipe until the required temperature is attained, the tap can be then turned off, and if a sudden reduction of temperature be necessary the tap which communicates with the cold water turned on.

If a temperature above the boiling-point of water be required, the box is filled with glycerine, and the heat from a spirit-lamp conveyed to it by means of a projecting copper plate, one end being in contact with the bottom of the box, the other in the flame of the lamp. In this way any ordinary temperature can be obtained, but it is not so completely under control as the steam, there being a rise of some 10° after removing the source of heat.

If a very low temperature is wanted, all the metalwork is covered with felt, and the box filled with clean crystals of ice and salt and water.

This stage is specially adapted for those cases where a rising or falling temperature is required. It was originally contrived for studying the tumefaction of starches, noticing the temperature at which the various granules burst, but I have found it useful also for ascertaining roughly the melting-points of fats, by observing when the crystals in them disappear; and for jellies, resins, and other structureless, easily fusible, substances, by noticing when small particles assume the liquid form; and it will obviously have many other applications.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Photographs of the Developmental Process in Birds.† — C. Kupffer and B. Benecke give fifteen photographic plates of the embryos of birds, with full descriptions, the outlines of the photographs being drawn on transparent paper, on which the necessary lettering is placed. A full description of the photographic apparatus is given, and it is stated that osmic acid was found to give to the embryos a colour suitable for photographic reproduction. When whole embryos are reproduced, the amplification is ten, and when one or other end only is photographed, it is twenty times. Some of the photographs are particularly good, and the tracings form admirable diagrammatic representations of the different relations of the parts. An important fact to which attention is drawn is, that within the limits of one species variations have been found to be much more marked in the earlier than in the later periods.

Development of the Paired Fins of Elasmobranchs.‡ — Mr. F. M. Balfour states that in *Scyllium* these arise as slight longitudinal ridge like thickenings of the epiblast, and that in *Torpedo* the anterior and posterior are on either side transitorily connected together by a line of columnar epiblast cells. Later on, the fins become a ridge of mesoblast covered by epiblast; the embryonic muscle-plates grow into the bases of the fins, and form two layers, while in the intermediate indifferent mesoblast changes begin to be set up, which give rise to the cartilaginous skeleton. There is thus formed in the fin a bar which springs at right angles from the posterior side of the

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Nova Acta Acad. Cæs. Leop.-Carol. Germ. Nat. Cur., xli. i. (1879) pp. 149–96 (1 pl. and 15 photos.).

‡ Proc. Zool. Soc. Lond., 1881, pp. 656–71 (2 pls.).

pectoral or pelvic girdle, and runs parallel to the long axis of the body. The free end of the bar begins to undergo segmentation into rays, and much of this is effected "before the tissue of which the plates are formed is sufficiently differentiated to be called cartilage by an histologist."

We have then a longitudinal bar along the base of the fin, which gives off perpendicularly a series of rays which pass into the fin. It is pointed out that, from its position this basal piece can never have been a median axial bar with rays on both sides. The resemblance to the arrangement of the unpaired fins is consequently very striking, and support is given to the author's original doctrine of a once continuous lateral fin.

Development of the Sturgeon.*—In continuation of his previous paper, Professor W. Salensky points out that in this fish it is very difficult to fix the limits between the period of the formation of the embryonic layers and that in which there appear the earliest rudiments of the organs. Here we find that the envelopment of the inferior by the superior portion, and the further differentiation of the embryonic layers is contemporaneous with the appearance of some of the organs in the mesoblast. Dealing with the modifications undergone by the egg up to the point at which the medullary groove becomes closed, the author states that organs begin to appear at the termination of the first day of development. On the second day a groove $0 \cdot 7'''$ in length appears in the middle of the embryonic area. The posterior extremity of this groove corresponds exactly to the blastopore. In the next stage the anterior end of this primitive groove dilates to form the rhomboidal rudiment of the brain. The hinder part of the groove opens directly into the primitive digestive cavity by means of the blastopore, and it is only near the end of the period of development that the union between the digestive and medullary cavities ceases to exist. Meantime, the lateral parts of the embryonic area have been undergoing important changes. On either side there appears a white band which behind diverges slightly from its fellow. These are the first indications of the Wolffian ducts; and the parts internal to them become modified to form the vertebral plates, and those external to them the lateral plates.

Previous, however, to the appearance of the groove on the surface of the embryonic area, important changes have been taking place within. There has appeared an axial thickening, formed from the ectoderm and mesoderm, which has an intimate connection with the formation of the notochord and of the central nervous system. These changes are described in detail. The mesoderm becomes divided into a median and lateral portions; the first constitutes the notochord, while the side pieces give rise to various organs. After the appearance of the medullary groove we may distinguish a central portion in which the groove is placed, and lateral parts which are distinguished by having over them the enveloping lamella. The bases of the cells which form the floor of the groove are strongly pigmented, and this

* Arch. de Biol., ii. (1881) pp. 279–341 (4 pls.).

pigment is derived from the ectodermal cells which become confounded with the cells of the medullary plates.

The further development of the nervous system consists in the progressive development of the lateral pieces which correspond to the medullary plates of other Vertebrates. At about this stage the parts of the mesoderm give rise to the excretory organs.

After the medullary groove becomes closed it is possible to distinguish a cephalic from a trunk region, and the boundary between the two corresponds to the anterior ends of the Wolffian bodies. Owing to the transparency of the embryonic area it is possible to see that the trunk grows by a gradual increase in the number of the primitive segments. Having before had five somites, we see these last increase as changes go on in the form and position of the blastopore. While the anterior segments retain their perpendicular position, the posterior become inclined to the longitudinal axis, to return later on to their primitive position. While elongation is proceeding, the trunk becomes thicker, the dorsal region increases in size, and there is exhibited a slight inclination to the right, the appearance of which causes a certain asymmetry in sections taken at this period.

Soon the blastopore closes, and its position is marked by an accumulation of pigment. The rudiment of the tail becomes visible by the formation of a tubercle; the cephalic extremity possesses two vesicles, and the mesoderm is still thin anteriorly. Where the cephalic plate enlarges, a central and a peripheral part may be distinguished, the branchial clefts begin to appear, and a facial process is developed in front of the head. The heart does not commence to contract till the end of the period of embryonic development, and its contractions are at first very slow. Simultaneously with this the veins and their ramifications appear.

The author next proceeds to a study of the development of the internal organs with which he considers the modifications of the embryonic layers. He points out that the ectoderm consists of two layers, of which the superior is, at first, strongly pigmented; throughout its development its cells nearly all retain their original flattened character; the lower layer is that which contributes most largely to the formation of the sensory organs in which, except in the case of the olfactory fossæ, the outer layer takes no part. After describing the details of the development of the central nervous system, Professor Salensky raises the question of the homology of this region with the nervous system of Vermes and Arthropoda. He points out that (1) the central nervous system of all Vertebrates is formed from two thickenings of the ectoderm, set parallel to the long axis of the body: that of all Articulates has a similar origin. (2) In some cases, e. g. *Echiurus*, the "Articulates" present a median groove comparable to that of Vertebrates. (3) The formation of the medullary groove commences, in the case of both phyla, posteriorly, and is continued forwards. On the other hand the Vertebrata have the central nervous system dorsal in position, and the medullary groove becomes closed. As to the first of these, he points out that the position of the mouth is the determining character, in conjunction with that of the loco-

motor organs; these points he looks upon as having less morphological value than the development of the system, and its correlation with other organs during the course of development. The closure of the medullary groove is regarded as being merely the result of further modifications.

If we accept the general homology, we have next to determine how the parts correspond; the author cannot follow Dohrn and Hatschek in regarding the homology as being complete; he looks upon the brain of Vertebrates as being a new formation, which is their exclusive property; it merely consists in an elongation and dilatation of the already existing nervous system, or in other words the medulla, which is the analogue of the ventral ganglionic chain of the Articulata.

The mesodermal derivates are dealt with in great detail, and a comparison with what is seen in Plagiostomi leads the author to say that they approach the higher, while the Ganoids approach the lower Vertebrata; and this portion of the essay concludes with an account of the development of the enteric tract.

Development of Petromyzon Planeri.* — J. P. Nuel directs attention to the phenomena of the contractility of the ovum: immediately after impregnation, before which the vitellus was everywhere closely applied to the chorion, the yolk commences to contract, till at last it is at all points separated from its investment. Calberla regarded this as being due merely to osmotic action, but the fact seems to be that a contractile wave, starting from the active pole, slowly but gradually passes over the whole of the yolk; this takes about twelve minutes to be effected.

From the moment when the egg begins to segment there is a period of rest between each division, and this period shortens as development advances; when the segmentation period is at an end the cells of the hypoblast are in repose for a lengthened period, while the epiblastic cells, continuing to divide, give rise to an epibolic invagination. At a certain period most of the hypoblastic cells start into activity, and the elements of the digestive tract begin to be formed; some of them, however, still remain quiet, and, only later, give rise to the liver. When a group of cells enter into activity, their calibre diminishes, and the yolk-grains are fused together.

After describing the details of the development of the digestive tract, M. Nuel states that the transformation of the yolk-spheres first takes place along the axis of the embryo; commencing at the anus of Rusconi, it rapidly extends forward; being most intense at the point where the epiboly is most advanced; thence it widens out, and gradually invades the whole surface of the hypoblast, till it comes into contact with the segmentation cavity.

When the mesoblast developes, it is clear that it has no relation to the *chorda dorsalis;* for the two are simultaneously differentiated from a common embryonic layer, which, later on, also gives rise to

* Arch. de Biol., ii. (1881) pp. 403–54 (2 pls.).

the secondary hypoblast; the mesoblast in *Petromyzon*, just as in the Sturgeon (Salensky) is developed from behind forwards.

The chapter on the germinal layer is largely occupied with a criticism of the observations of W. B. Scott; and the author concludes by giving his adhesion to the doctrine of His, that the study of the mechanical causes which affect the embryo, and the causal connection of the changes which take place in the egg are the true objects of embryology, and he points out that this side of the study is to descriptive embryology what physiology is to zoology.

White Corpuscles of the Blood.*—M. Renaut describes the different forms presented by the white corpuscles in different animals. In the Crayfish, besides the ordinary lymph-corpuscles, there are many larger bodies with well-defined nuclei, the protoplasm of which contains large highly refracting granules, resembling in many respects the vitelline granules of the Frog and other Batrachia. These corpuscles have a sharply limited, but thin exoplastic pellicle; and if a drop of such lymph be allowed to fall into a drop of a 1 per cent. solution of osmic acid, the white corpuscles are instantly fixed, with their pseudopodia or protoplasmic processes extended; and these processes can then be seen to perforate the thin membrane, now blackened with the acid. There are thus two kinds of white corpuscles in the Decapod Crustacea—the lymphoid corpuscles and the amœboid corpuscles.

Do similar differences exist in the blood of Vertebrata?

In reply to this, M. Renaut states that in the blood of all the Vertebrata, from the Cyclostome to the Saurians, the white corpuscles are of two kinds; one, the ordinary white corpuscle, composed of hyaline protoplasm, presenting many short projecting points, with a nucleus undergoing gemmation, and sending forth branched pseudopodia when placed under favourable conditions; the other containing numerous brilliant granules imbedded in the protoplasm and surrounding the nucleus. These resemble the second form of corpuscle described above as existing in the lymph of the Crayfish, but differ from them in having no outer limiting layer of condensed protoplasm, or exoplasm, as Haeckel has named it. The application of osmic acid shows that they may be subdivided into two other forms, one closely analogous to cells undergoing transformation into fat-cells, which present numerous granules, and stain black with osmic acid, and another set which contains granules that are not fatty, but which stain red with eosin. The best mode of demonstrating the existence of these three forms is to fix the blood in the rete mirabile of the capillary layer of the choroid in the posterior segment of the eye of a frog, by removing the anterior segment and exposing it to the vapour of osmic acid. At the expiration of twelve hours the eye is removed from the vapour, washed, the chorio-capillaris detached from the retina, and spread on glass; it is afterwards coloured with, and mounted in, hæmatoxylate of eosin. The corpuscles may then be studied, and the three forms of ordinary, granular, and fatty corpuscles can be easily distinguished.

* 'Science,' ii. (1881) p. 505, from 'Arch. de Physiol.' and 'Lancet.'

M. Renaut finds that the white corpuscles of mammals generally, and of man in a state of health, all closely resemble each other, and are of the ordinary kind; but in disease, as in leucocythæmia, the white corpuscles are not only greatly increased in number, but vary considerably in size. Moreover, they are round, and present no pseudopodia. They are hyaline, and have a smooth, well-defined limiting membrane, and some of them have nuclei which have undergone fission, just as in a cell that is about to segment. Hence, he is of the opinion that the white corpuscles multiply and increase in number while floating in the blood; other corpuscles may be observed, which are charged with granules of some proteid substance, resembling vitelline granules, or small masses of hæmoglobin; and, lastly, there are still other cells, which are charged with fat. M. Renaut has made some observations on the development of the red corpuscles of the Lamprey, and gives the following succession of forms. White corpuscle with nucleus proliferating and protoplasm not limited by an exoplasmic layer; corpuscle with nucleus proliferating, the protoplasm forming an uncoloured disk, limited by an exoplasm; corpuscle with proliferating nucleus, protoplasm limited by an exoplasm, and forming a disk, more or less charged with hæmoglobin; red corpuscle with proliferating nucleus; and finally, circular red corpuscle, with rounded nucleus.

Nerve-endings of Tactile Corpuscles.*—W. Krause discusses the different views which have been held as to the condition of these nerve-endings, viz.:—(1) Langerhaus, who considers that the fibres divide di- or trichotomously after entering the corpuscle, and end thus by only two or three terminal twigs which may be flattened into terminal disks, as is generally the case in the end-bulbs, and especially in the round ones. (2) Ranvier, who states of the laminar terminal corpuscles of the tongue of water-birds, &c., and of the laminar tactile corpuscles, that a terminal disk is interpolated between every two of the cells which lie transversely in the bulbs. Krause obtained similar results by the use of formic acid and chloride of gold. (3) Meissner, from pathological and other observations, has set down all the transverse striation to nervous structures, except some possibly due to nuclei. But Krause, supported by Fischer and Flemming, has explained the large number of transverse nervous terminal fibres as due to a spiral course of the latter, accompanied by repeated dichotomous branching.

In order to reconcile the three views, it may be held that Langerhaus' opinion applies to some of the smallest and simplest corpuscles; while Ranvier's apply to their larger and more usual forms; whereas Fischer's preparations show the course taken by the terminal fibres in reaching their disks. Krause himself holds the inner bulbs to consist of transverse bulb-cells with pale terminal nerve-fibres ending in knobbed or discoid terminations between them.

* Arch. mikr. Anat., xx. (1881) p. 215 (1 pl.); and Biolog. Centralblatt, i. (1881) pp. 462–3.

Distribution and Termination of Nerves in the Cornea. * — Opinions have differed widely as to the actual mode of termination of the corneal nerves, whether singly or by fasciculi in the corneal cells, or by reticulations surrounding them. These and kindred questions have been investigated by Professor G. V. Ciaccio. He has studied animals from all the Vertebrate classes except fishes, and has chiefly employed chloride of gold to render the nervous elements visible. His results are summed up as follows: —

1. The nerves of the cornea are of different kinds and have different functions, viz. (*a*) sensitive, some to light and some not, and (*b*) trophic, regulating the nutrition of the tissue.

2. They form a plexus, the "circumferential nervous plexus", at the circumference of the cornea before entering it; this consists partly of medullated, partly of non-medullated fibres.

3. This plexus sends out branches and twigs of different sizes in various quantities, which enter the cornea, divide and subdivide there and form a plexus, the "primary or principal nervous plexus," which traverses its entire breadth; in the rabbit, mouse, rat, and bat it lies chiefly near the anterior face; in lizards, tortoises, frogs, and tritons it is near the middle of its thickness; in birds it is mostly contained in its anterior portion.

4. Other plexuses exist in this organ, more or less derived from or dependent on this chief one; they are termed secondary or accessory; they sometimes lie above, sometimes below the chief one. In the frog this plexus lies below the latter, and close to Descemet's membrane; in the mouse, it lies above, close to the anterior face of the cornea and thus constitutes the "subbasal plexus" of Hoyer and others.

5. The principal plexus gives off a large number of small branches, sometimes accompanied by ultimate fibres; they are termed "perforating branches"; they break up first below the epithelium, each into a tuft of fibrils, which form between themselves the "subepithelial plexus," of greater or less closeness, and differently arranged in different animals. In the mouse and rat, and perhaps the bat, it has a concentric arrangement, but the centre does not correspond to that of the cornea.

6. From different places in the subepithelial plexus fibrils go off and enter the epithelium, dividing and anastomosing, and thus forming in it a very delicate reticulation, probably broken off here and there, (the intra-epithelial rete or plexus of modern authors); the fibres terminate either in small button-like dilatations or simply below the outermost cells of the epithelium, which form a delicate membrane interposed between these endings and the exterior.

7. The various plexuses and networks thus formed are not to be considered as so many distinct units but as so many compound systems, each of them being made up of as many parts as there are nerves entering into its constitution. Thus, by their distribution over the cornea, the nerves form just so many anatomically and physiologically distinct regions as there are trunks and branches of nerves.

* Mem. Accad. Sci. Ist. Bologna, ii. (1881) 24 pp. (2 pls.)—Sep. repr.

8. The nervous fibres, both those of the proper substance of the cornea and those of its epithelium, always terminate in two ways, namely, by plexus or reticulation and by free ending. The latter mode, when occurring within the cornea, takes place not only in the branching cells but also within or between the fibrous laminæ.

9. The axis-cylinders of the corneal nerves are made up, like the fibres of striated muscle, of fibrils, each of which consists of minute particles and of a peculiar intermediate substance which unites them in linear series; in this case these particles are round, whereas in muscle they are prismatic.

Influence of Food on Sex.*—The results of experiments detailed by E. Yung tend to confirm those previously obtained by G. Born,† who found that when young tadpoles were subjected to special kinds of food (in one case vegetable food being given, in another mixed vegetable and animal), a large preponderance of females were developed. In these experiments there was an absence of what forms the chief normal food of tadpoles, viz.—marsh-slime, containing various organic detritus, rotifers, infusoria, diatoms, &c.

Yung reared the tadpoles of *Rana esculenta* in four vessels, feeding the broods respectively on fish, meat, coagulated egg-albumen, and egg-yolk. The percentage of females in each case was 70, 75, 70, and 71. In a fifth vessel, out of a brood of 38 tadpoles nourished simultaneously on meat, algæ, and white of egg (without slime), 30 were females, six males, and two doubtful. These results seem to demonstrate that the quality of the food experimented with exercised no distinct influence on the sex, but that a special diet given to young tadpoles from the time of hatching favours the development of a female genital gland, as Born concluded.

B. INVERTEBRATA.

Mollusca.

Digestion of Amyloids in Cephalopoda.‡—E. Bourquelot in attempting to resolve the contradictory statements that have been made with regard to the presence of a diastatic ferment in the liver of the Cephalopoda, finds that the quantity of starch which is altered varies with the condition of the individual. When it is starving the action is slow and difficult to detect, for the gland is then in repose; but when digestion is going on in the animal the change is almost instantaneous. As in mammals, ruptured starch-grains are alone acted on. It is somewhat curious, the author thinks, to find this ferment in carnivorous animals, but its presence affects the discovery of the possible glycogenic function of the Cephalopod's liver. Can glycogen and starch-ferments exist in the same gland? as yet there is no proof of the presence of sugar in livers that have been properly treated, but, as the author justly remarks, in physiological chemistry an experiment yielding negative results should be frequently and carefully repeated.

* Comptes Rendus, xciii. (1881) pp. 854–6.
† See this Journal, i. (1881) p. 874.
‡ Comptes Rendus, xciii. (1881) pp. 979–80.

Proneomenia sluiteri.*—Dr. A. A. W. Hubrecht gives a full anatomical account of this interesting archaic Mollusc, the discovery of which we have already noted.† There are no external appendages; the groove enclosing the foot is indicated by a dark longitudinal line, the mouth and anus are at either extremity. The integument is stiff owing to the presence of several layers of spicules of carbonate of lime; externally to the circular layer there is a cellular one, which appears to be the matrix of the integument; and there is an interspicular substance which is homogeneous and structureless, and appears to be of a chitinous nature. The youngest spicules are found quite close to the deep cellular layer of the matrix; the older ones are in communication with this layer by radiating cords of connective tissue, and the points of the innermost project towards the exterior. So far there are certain important differences between this form and *Neomenia*, and, in the latter, blood-vessels find their way into the skin; moreover, in *Proneomenia* at the hinder end of the body there are two symmetrically developed cæca connected with the anal cavity, and containing a special secretion; they are provided with a strong muscular investment, so that, whatever their homology or functions may be, there can be no doubt that at times their contents may be forcibly expelled.

In his account of the muscular system the author states that in *Proneomenia*, as in *Neomenia*, the stronger muscular fibres are enclosed in a delicate sheath of connective tissue, which forms transverse folds and so gives to the muscle the appearance of being striated. The most anterior portion of the ventral groove leads into a system of ciliated slits and cavities which ramify and communicate with one another; the whole would seem to form a gland—the "anterior foot-gland." The posterior foot-gland has no ciliated cavities.

The nervous system truly belongs to the type of the *Amphineura;* the single cephalic ganglion is comparatively very small; it gives off three separate pairs of principal trunks, the innermost of which forms, as in *Chiton*, a sublingual commissure; the second pair surrounds the pharynx and developes the anterior pedal ganglia; the third pair gives rise to the longitudinal lateral nerves, and "a regular series of commissures similar to those between the two pedal nerves, connect the two lateral with the two pedal nerves." The study of the details of the nervous system reminds Dr. Hubrecht that all late investigations into the lower Invertebrates appear to point towards an increased complication of the commissural connections, culminating in the direct continuity of nervous tissue throughout more or less extensive regions of the body. It is remarkable further, that "the lower we descend in the Molluscan subdivision the more a system of transverse commissures between the longitudinal connective stems fixes our attention." Perhaps, indeed, the earlier Mollusca had their nervous system plexiform in arrangement. Further, the fact is of

* Niederl. Arch. f. Zool., Suppl. Band I., ii. (1881) 75 pp. (4 pls.).
† See this Journal, i. (1881) p. 28.

importance that the primary nerves are accompanied by a layer of nerve-cells.*

The digestive system is divisible into a muscular buccal mass, a ciliated intestine and the rectum; the pharynx possesses a number of radial folds, and there is an inner coating of a yellowish chitinous cuticle. No trace of a radula is to be seen in *Neomenia*, but in *Proneomenia* it is interesting to observe a muscular process representing the tongue and invested in chitin; salivary glands appear to be present. The intestine is uniform throughout, with thin walls, provided anteriorly with a cæcum; the lumen is obstructed by the deep transverse folds, found in this form and its allies, and there are indications of an incompletely differentiated liver, in the form of secreting cells on the lateral portions of these laminæ.

The generative system is perfectly symmetrical, and consists of the germ-gland, which is situated along the whole length of the body, and is dorsal, and of the different cavities and canals found at the hinder end of the body. The general type in the Solenogastres appears to be the possession of a double genital gland which communicates with the pericardium; from this a complex of ciliated and glandular ducts leads towards the exterior, to which it opens in the region of the anus. The author thinks it possible that part of the conducting tubes of the genital system represent the kidney. If this view is supported, we shall find in *Neomenia* a form in which the genital products are discharged by a pair of ducts into the body-cavity (pericardium); thence they are conducted by paired ciliated ducts into the cavity of the kidney; in other words, we have indications of a more primitive stage in which the cavity of the pericardium was the meeting-point of the efferent ducts of the genital glands, and the excretory ducts of the renal organ.

The circulatory system is almost completely lacunar, the heart is more or less saccular in form, and as radiating fibres traverse its cavity, it has a resemblance to the embryonic heart of some higher Gastropods: it is possible that the blood-corpuscles contain hæmoglobin. There appear to be no branchiæ at the posterior extremity of the body. The paper concludes with a detailed comparison of this form with *Neomenia* and *Chætoderma;* and of the Solenogastres generally with the other division of the Amphineura—the Polyplacophora.

Molluscoida.

Development of Salpa.†—Professor W. Salensky has a preliminary communication on this subject, to which his attention has been compelled by the different results obtained by Brooks and Todaro, as compared with those of his own earlier investigations. He now finds that there are great differences between the *S. democratica* which he previously examined, and the *S. pinnata*, which was the subject of Todaro's studies. In all species of *Salpa* the ovary is found at the hinder end of the body, and consists of an egg-cell, enclosed in a

* We may observe that Balfour has noted a number of commissures between the ganglia, and a ventral ganglionic layer in the ventral cords of *Peripatus.*

† Zool. Anzeig., iv. (1881) pp. 597–603, 613–19.

follicular capsule; this follicle has a solid stalk, which leads into the oviduct; where the wall of the respiratory cavity is connected with this, it is thickened, and the projection so formed was taken by Todaro for the uterus; the maturation of the ovum is always accompanied by the shortening of the stalk, till the follicular cavity becomes connected with the oviduct. After this impregnation takes place.

In further development differences obtain between the species as to the form of the embryo, of its coverings, and of the number of follicular cells. Considerable differences are seen early between *S. democratica* and *S. bicaudata;* the former has no amniotic fold, the latter lies in a prolongation of the body, formed from the cellulose-mantle, blood sinuses, and a tubular continuation of the wall of the respiratory cavity. The first signs of the differentiation of the central mass is the separation of the lower wall of the follicle, and a cavity is thus formed which the author proposes to call the follicular cavity, instead of applying Todaro's unsuitable term of cleavage-cavity; this wall becomes the upper wall of the placenta. In *S. pinnata* the nervous system arises in the form of a tube with an at first narrow lumen. In the other species the ganglion has the form of an aggregate of cells, derived from the follicular cells. From the connecting canal between the enteric and neural cavities we have formed a ciliated pit. An account is given of the formation of a special organ known as the subpericardial aggregate of cells; Uljanin has informed the author that a similar structure is to be observed in *Doliolum.* The elæoblast is formed from the amœboid follicular cells which give rise to the blood-corpuscles and muscles.

The author insists on the great differences between the developmental history of *Salpæ* and that of other animals, the organs being formed not from the cleavage, but from the follicular cells; something similar has, however, been noted in the allied *Pyrosoma;* and, instead of speaking of development of *Salpæ,* he would prefer to give the process the name of follicular gemmation.

Tunicata of the 'Challenger.' *—In a fourth communication Dr. W. A. Herdmann deals with the Molgulidæ, and describes *Molgula pedunculata, horrida, forbesi,* and *pyriformis, Eugyra kerguelenensis; Ascopera* is a new genus with a pyriform, more or less pedunculated body, the test thin, while the branchial sac has seven folds on either side: *A. gigantea* and *A. pedunculata.*

Arthropoda.

α. Insecta.

Striated Muscle of Coleoptera and its Nerve-endings.†—The main results obtained by Professor L. v. Thanhoffer on this subject show the striated muscle of Coleoptera to possess two separate sarcolemmar membranes, between which the nerve-ending plate spreads

* Proc. Roy. Soc. Edinb., 1881, pp. 233–40.
† Biolog. Centralblatt, i. (1881) pp. 349–51.

out, the axis-cylinder of the nerve dividing dichotomously, and the nerve forming a reticulum in the plate. In the Frog no such reticulation is formed, but the divisions of the axis-cylinder come into contact with the nuclei which overlie the muscle-fibre. In the beetle the nerve-substance of the plate is separated from the muscular substance by a membranous structure which is connected with Krause's transverse lines. Strong contraction, produced by electricity, causes resolution of the transverse lines of the muscle into molecules; but fine striæ, due to the approximation of Krause's lines, are still to be seen, except after very violent contraction. All the described forms of cross lines can be seen in the Coleopteran muscle. The outer sarcolemmar sheath is in connection with the outer sheath of the tendon; a reticular lymphatic canal-system ramifies from the latter and terminates in the uniting substance of the fibrils, showing cell-like granular structures at the points of division.

These canals show connective-tissue cells bearing processes shaped like windmill-sails at the point of insertion of the tendon. The main nerves of the muscles lie in special "perineural" cavities, lined with a multilaminar sheath. Isolated muscular fibres of *Hydrophilus piceus*, connected with end-plates, show the Krause's lines next to the membraneous neural septum to be in close apposition, whereas towards the sides they become gradually more distant; they appear to converge towards the plate when near it, but to diverge when remote from it.

Terminations of the Motor Nerves in the Striated Muscles of Insects.*—H. Viallanes has studied the mode of termination of the nerves in the muscles of the larvæ of *Stratiomys chamæleon* Macq. and *Tipula gigantea* Macq., and finds that in both the muscular fibre is on the same plan as that of Vertebrata; and consequently differs greatly from that of adult insects, which is histologically distinct. The results which he obtained cannot therefore be compared with those obtained by most of his precursors, who studied chiefly adult insects.

In *Tipula* each muscular fibre receives only a single nerve, and has only one Doyère cone: but in *Stratiomys* each receives several nerves, and has several Doyère cones.

The sheath of the nerve continuous with the sarcolemma constitutes the wall of the Doyère cone.

The axis-cylinder having penetrated to the summit of the cone divides into two principal branches, which give off secondary branches; these again divide dichotomously a great number of times. There results a terminal nervous plexus beneath the sarcolemma, and comparable to that in the Vertebrata. The author claims to have been the first to point out such a plexus in other animals than Vertebrata.

This plexus occupies a considerable area in *Tipula*; but is much reduced in *Stratiomys*.

As in the Vertebrata, all the branches of the plexus are situated between the sarcolemma and the contractile mass; they seem to terminate in a slender point as in the frog.

Special nuclei are adherent to the branches of the plexus, and

* 'Thèse pour le Doctorat en Medicine,' 8vo, Paris, 1881 (45 pp. and 3 pls.).

accompany them throughout their course. These the author calls "nuclei of the plexus" (*noyaux de l'arborisation*), comparing them to those so named in the Vertebrata.

In *Tipula* there is attached to the principal branches of the plexus a granular substance provided with special nuclei, which must be compared to the "fundamental nuclei" and "granular substances" of the plexus of the higher Vertebrata. They are completely wanting in *Stratiomys.*

Between the plexus of *Stratiomys* and *Tipula* there exists a difference analogous to that observable between the plexus of the frog and that of the lizard.

These results do not necessarily invalidate, the author says, those of Ranvier and Foettinger, because he has dealt with a histologically different matter. They confirm, however, the observations of Rouget, who has described the axis-cylinder as forking in the interior of the cone, the two branches of the fork being applied to the surface of the contractile mass but not appearing to extend further. They also confirm his view that the granular matter which fills the cone is of little importance, being absent in *Stratiomys.*

Wings of Insects.*—Dr. G. E. Adolph figures a large number of wings chiefly of Hymenoptera, and points out that the arrangement of the concave and convex lines is the most constant character, but that the concave are much more persistent than the convex. A study of the arrangements seen in *Vanessa* has shown him that the tracheal system of the wing is first developed along certain primary lines, the most primitive and striking peculiarity of which is their tracheal nature; between these there are developed certain costal elements. After dealing with the Lepidoptera he passes to the Diptera, and in their case, as in that of the Neuroptera, he institutes a comparison with the Hymenoptera, pointing out how fresh branches become developed and earlier nervules absorbed.

In a second paper † he deals with certain abnormal developments in the wings of some *Hymenoptera.*

Structure of the Proboscis of Lepidoptera.‡—W. Breitenbach, dealing with the phylogeny of this organ, finds in the early stages of the insect indications of its origin, for in the late larva it has been found already represented by two long curved cords. But further, the obvious connections of the group with the Trichoptera show that the biting mouth of the latter has produced the sucking tube of the former by modification of the labium, maxillæ, and labrum, which were at first all united into a tubular organ; the edges of the two maxillæ then became more closely approximated, and the share of the other two parts in the organ became unnecessary, and they were excluded from it. This metamorphosis, however, was probably made in various stages, each having some definite advantage to the insect as its object: e. g. the exclusion of the labrum and labium from the organ was a

* Nova Acta Acad. Cæs. Leop.-Carol. Germ. Nat. Cur., xli. ii. (1880) pp. 213–92 (6 pls.).

† Tom. cit. pp. 293–328 (1 pl.).

‡ Jenaisch. Zeitschr. Nat., xv. (1881) pp. 151–214 (3 pls.).

beneficial simplification, the great object being to bring the two maxillæ together; the latter organs were able to assume a greater development in consequence of the reduction of the former; this development was further promoted by the abnormal method by which food was obtained. The increase in the length of the tube was caused by the depth which the nectaries of certain flowers exhibited, and by which they excluded insects hurtful to them, while, at the same time, this very depth allowed of the accumulation of a greater amount of honey.

The transverse striation of the tube, noticed by Réaumur, is produced by semilunar bands of chitin, which are set side by side from the root to the extremity of each half-tube in two series of half-hoops, exterior and interior; the degree of their development varies in different insects; they are most slender at the apex, a fact which is partly due to the space occupied by certain papilloid processes on this part. The form of the bands also varies; in some Lepidoptera they are broken up into a series of separate chitinous pieces; sometimes, as Gerstfeldt has observed, they are forked, but in this case they are divided only into two arms, not three, as stated by that observer. The transition from the condition in which the bands are composed of series of separate pieces to that in which they form continuous strips is well seen in passing from *Pieris* to *Vanessa*, though even in the latter genus (e. g. *V. cardui*) the transverse chitinous series are not wholly united into bands. It is uncertain whether the disconnected or the consolidated form of the chitinous bands of the tube is the primitive condition. The apposed edges of the two halves of the tube may be either serrate (*Egybolia*) or plain (*Argynnis*).

The *apex* of the proboscis presents, as already well known, certain organs called juice-borers. The simplest form of these is (1) that of simple hairs, which occur on every proboscis, and consist of a basal chitinous ring, the "cylinder," and a true hair-shaft, which is traversed by a horny mass, the "axial radius," termed "central mass" in the juice-borers; the cylinder is usually imbedded in the main substance of the tube. When true sap-borers coexist with them, the hairs are short, and *vice versâ*. The varieties in form of the juice-borers are caused by varieties in the peripheral portion of the shaft. 2. Juice-borers, with the upper edge of cylinder dentate, e. g. *Vanessa*. Cylindrical or barrel-shaped, the teeth are six to eight in number, moderately sharp; in *Pyrameis virginiensis* they are cylindrical, laterally compressed. 3. Juice-borers with longitudinal ridges formed by the chitinous covering of the "central mass" which spreads out into six plates, running parallel to its axis, e. g. *Catocala*, *Noctua*, *Plusia*, *Mamestra*, *Agrotis*, *Triphæna*, *Phlogophora*, *Tæniocampa*, *Euclidia*, &c. 4. Juice-borers of *Arge Galathea*. Upper surface armed with six teeth, and three similar whorls of teeth in succession below them, parallel to the first series; the points are directed towards the apex of the organ. 5. Unarmed juice-borers; e. g. those of *Argynnis*, *Melitæa*, *Ageronia Arete*, *Macroglossa*, *Hesperia*, *Taygetis Xanthippe*, *Heliconius*, *Eneides*, *Agraulis*, &c. 6. Juice-borers of *Scoliopteryx libatrix*. Of two forms. (*a*) A thick-walled cylinder,

the edge armed with two blunt processes, the point of the central mass projecting between them, and armed with chitin. (*b*) as (*a*) but the point of the central mass prolonged to as great a length as the cylinder itself, or greater. 7. *Egybolia Vaillantina.* A very thick-walled cylinder, the central mass projecting by a small conical process from its extremity. A form allied to this is exhibited by an Australian moth, viz. a pointed cylinder, the central mass projecting from its side as a very small process. 8. Recurvate juice-borers. Recurvate hooks, calculated to lacerate the tissues when the proboscis is withdrawn from a soft vegetable mass into which it has been plunged; e. g. *Ophideres*, *Achæa chamæleon*, *Egybolia Vaillantina*, *Scoliopteryx libatrix.*

Functions of Juice-borers.—The object of obtaining supplies of juice is clearly that of the last form; that of the simplest forms must be sought in their origin from simple hairs, which must have been originally organs of touch; but, in spite of Fritz Müller's view as to the general prevalence of this latter function, they must be considered, from their structure and position, to be truly and solely instruments for extracting juices. The cases in which the structure of these organs is known are too few at present to base classificatory systems upon them, and in some cases they appear to be little adapted for such a purpose, as, for example, the form with longitudinal ridges (No. 3), which occurs in numerous European genera of each of the three groups, *Bombyces*, *Noctuæ*, and *Geometræ*, besides some genera of uncertain position. In the Micro-lepidoptera they have not been examined.

Internal structures of the halves of the proboscis.—The muscles consist of a main longitudinal band passing from base to apex, and of numerous small branches passing off obliquely from it, and attached on the upper side; the latter cause the tube to roll up by contracting first near its apex, and then in succession towards the base. The nerves are not known. A tracheal tube traverses each of the maxillæ, ending blindly at its apex.

The closing of the two halves, in a species of Sphinx, is effected by two different arrangements. The lower edges are joined by means of a pair of teeth in each half (as seen in transverse section), which interlock with those of the opposite half; on the upper side the integrity of the tube is effected by fine hairs and spines in the two halves, which cross and form a kind of joint. Similar arrangements appear to occur in some other forms. The act of sucking appears to be caused, not by exhaustion of air by means of the tracheæ, as would be the case if the method had an analogy with that of higher animals, but by partial separation of the two halves of the tube, causing attenuation of the enclosed air, and forming an imperfect vacuum, which thus allows the pressure of the external air to act on the juices of the flowers attacked by the insect.

Post-embryonic Development of Diptera.*—H. Viallanes, noting that of all insects the Muscidæ exhibit the greatest differences between

* Comptes Rendus, xciii. (1881) pp. 800-2.

the larval and the perfect state, has continued the investigations of earlier naturalists by a study of *Musca vomitoria*. When the larva becomes converted into the pupa, the skin of the whole of the body, and not only that of the head and thorax, undergoes degeneration of the hypodermic cells; and this is carried so far, that at one time the animal has nothing but a delicate cuticle covering it; the embryonic cells which fill nearly the whole of the body of a pupa are not all derived from the nuclei of the muscle-cells, some are formed by the proliferation of the cells of the fat-body. It is pointed out that the return of the tissues to the embryonic condition is the cause of the pupa having, at a certain time, really the characters of an embryo; if we make a section across the abdomen of a pupa between the second and fourth days we see that it is only composed of two layers of central cells, one formed from the epithelial cells of the digestive tube and the other, set peripherally, and formed by embryonic cells derived from the muscular nuclei and the cells of the fat-body. The imaginal disks seem at first to form a hollow sphere in which one part has been pushed into the other; the inner layer is thick, and made up of pyriform cells, the outer layer is delicate, and its cells flattened. Later on, the latter disappear, and the inner layer gives rise to the integument of the adult. The disks for the eyes are distinguished by having the cells of their inner layer regularly set side by side; they are cylindrical in form, and their inner extremity is pointed; by this they become connected with the fibrils of the optic nerve. The author finds that the integument of the abdominal region of the adult is formed by the conversion of the embryonic into hypodermic cells, the hypoderm first appearing, for each joint, at two superior and two inferior points. Further observations are promised which will deal with the metamorphoses of the nervous system.

Criticizing the statements put forward by Viallanes, Künckel* points out how the author's view, that the embryonic cells are partly formed by proliferation of cells of the fat-body, has been contradicted by his own observations and those of Ganin, which show this body to be no more than a reserve of nourishment, in other words, a post-embryonal vitellus. The buds which give rise to the integument of the head and thorax have been wrongly termed "histoblasts" by Viallanes, for they have not, as the term would imply, a common origin and common constitution, but give rise to the nerves, tracheæ, and the skin itself; their structure has been rightly elucidated by Ganin as that of small sacs filled with cells, and as having an exoderm and mesoderm. The development of the hypodermic cells, as already described by Ganin, is essentially the same as that described by Viallanes.

A justification by Viallanes of his statements is given in a subsequent paper,† in which he points out that Ganin regarded the hypodermis of the abdomen of the adult as being developed by transformation, while he has proved that there is a true degeneration of the cells.

* Comptes Rendus, xciii. (1881) pp. 901–3.
† Loc. cit. pp. 977–8.

Development of Adoxus vitis.*—M. Jobert has been studying the generation of this, next to *Phylloxera*, most dangerous enemy of viticulture. A smaller and a larger form are to be distinguished, but dissection shows that they are both females. A little above the point where the ovary joins the oviduct, a spermatheca opens by a duct; it forms a well-developed glandular organ without any copulatory pouch. Two long tubular glands also open into the vagina. The idea arises that the males died before the females came out, or that they do not resemble the females; however, the author was on no occasion able to detect the presence of spermatozoa in the copulatory pouch. One hundred insects were collected, of which 50 were dissected and found to be unimpregnated females; the others were kept alive and isolated. After some time they laid each from 25 to 30 eggs; two were immediately killed, and still found to be without spermatozoa. The eggs that were laid were fertile.

As against the theory of parthenogenesis we have to note the possibility of hermaphroditism, for at the moment of oviposition the tubular glands are well developed, and contain a mass of a refractive substance, which, when highly magnified, resolved itself into a prodigious quantity of vibratile rods, one-hundredth of a millimetre long.

Colouring Matter from the Willow-tree Aphis.†—Mr. C. J. Muller finds that the abdomen of *Lachnus viminalis*—an Aphis which feeds on the juices of the bark of the willow-tree—is filled with hard granules, like grains of sand variously coloured, green, red, and yellow. A gentle heat fuses them, and the fused mass on cooling exhibits under the polariscope all the characteristics of salicine. This is best seen by digesting the insects in pure benzole, the deep red solution then obtained being afterwards evaporated on a glass slide. The author considers that the colouring matter belongs entirely to the juices of the tree on which the insect feeds, and that it is not in any way manufactured by the Aphis (except in so far as animal heat and the digestive process may influence it), so that if this opinion is correct, it would account for Dr. Sorby not finding in the red Apple Aphis the physical and optical properties of the colouring matter of the Cochineal insect. The latter feeding upon a plant altogether different from the apple, the character of its colouring matter will necessarily differ.

γ. Arachnida.

Liver of Spiders.‡—Dr. P. Bertkau states that the gland which has been so called, lies in the hinder part of the body, where it is divided by the heart and intestine into two halves; in most species it completely invests the generative organs and spinning vessels. The gland is follicular in structure, the separate follicles being united into larger masses by the *tunica propria*. The cells are large and cylindrical, and they contain a quantity of large and smaller spheres,

* Comptes Rendus, xciii. (1881) pp. 975–7.
† Proc. Eastbourne Nat. Hist. Soc., 18th Nov., 1881 (6 pp.).
‡ Zool. Anzeig., iv. (1881) pp. 543–4.

the former of which lie near the lumen and the latter near the wall of the gland. Between the separate follicles we find a connective tissue with the characters of fat-cells and traversed by renal canaliculi. The secretion of the gland is neutral or faintly acid; on being dried and heated with fibrin it gave its distinct peptine reaction, which was most marked in alkaline solutions; it appears to possess both a tryptic and a peptic ferment.

Limulus an Arachnid.*—Professor E. Ray Lankester examines part for part the apparently corresponding structures of *Limulus* (the King-crab) and a Scorpion. Commencing with the nervous system, an exact knowledge of which in the latter is still a desideratum, he points out that in *Limulus* we have (*a*) an archi-cerebrum whence five nerves only are given off; (*b*) an œsophageal collar whence nerves radiate to all the pediform gnathites, as well as to the chilaria and the genital operculum, there being a distinct nerve for each appendage; (*c*) the first half of the abdominal cord gives off no nerves, the latter five pairs. Precisely corresponding portions may be made out in *Scorpio*, where, however, the brain and the œsophageal collar are more intimately fused; Newport's figure shows that the nerves "have a lateral position embracing the true archi-cerebrum." What Professor Lankester calls the *attraction* of nerve-organs to the œsophageal collar has gone further in *Scorpio* than in *Limulus*, for the nerves for the segments containing the first two pairs of lung-books likewise arise from the collar itself.

The striking resemblances between the skeletons of the two forms are next illustrated, and it is pointed out that the so-called compound eyes of *Limulus* are more correctly regarded as aggregations of simple eyes; the differences between the abdominal regions are diminished when we remember that the embryonic *Limulus* has a series of separate segments in this region, the presence of which is still denoted by a series of ridges and by the lateral spines, each of which would appear to possess its separate musculature, as well as by the dorsal pits or "entapophyses." Between this and the anus, *Limulus* has an area which is only potentially segmental, and behind these comes in both a telsonic spine. Behind the six cephalothoracic appendages there is the genital operculum, a lid-like plate which in *Limulus* retains throughout life indications of its double origin, but in *Scorpio* is only bifid at its free margin. As is well known, the 8th pair of the appendages in the Scorpion are the *pectines;* in the King-crab, the pieces on either side become united across the middle line, but on their under surface there is still to be seen "a series of very delicate lamellæ, corresponding to the lamelliform teeth of the Scorpion's comb-like appendages. Precisely similar pieces are found on the 9th–12th appendages of *Limulus*, but in the Scorpion the rudimentary appendages have disappeared," but only from view—in other words, the lamelligerous appendages of these four segments sink within the lung-invaginations. When a close examination of the sternal area of this region of *Limulus* is made stigmata are found which lead into

* Quart. Journ. Micr. Sci., xxi. (1881) pp. 504–48 (2 pls.).

pits; these parabranchial stigmata are found on the posterior face of the median sternal lobe which unites the two halves of the lamelligerous appendage; they are connected with powerful muscles, the function of which is clearly to agitate the plate-like organ, for the purposes of respiration. A still more intimate knowledge of the structure of the lamelligerous appendages in the two forms reveals their essential similarity in structure; an axis springing from the body-wall has its posterior face provided with a transverse series of lamellæ; when these are all set in a corresponding position we find that they are always imbricated, and that the imbrication is identical in all, and that they only present such differences, as density of structure, &c., as are to be explained by a reference to their different positions and functions. The history of these structures is next hypothetically detailed, and it is pointed out that in living Scorpions the original stigma has closed up and that a new opening (the stigmatic slit) has been developed within the area formed by the closure of the stigma; and air now enters where before there was blood.

The characters of the free entosternite in the two forms are then described and compared; and it is stated that in no Crustacean are such developments to be observed. The alimentary tract is similarly treated, and the fact that the proctodœum is so short in *Limulus* is stated to be one of the most important points of difference; but this itself is only a part "of that general reduction of its hinder segments"; another difference is the absence of Malpighian glands in the King-crab. This portion of the paper concludes with an account of the circulatory and generative organs.

The *Eurypterina* present numerous well-marked indications of forming a link between the two forms here compared together. After a review of the opinions held by preceding writers, Professor Lankester proceeds to the development in time of *Limulus* and the Tracheate Arthropoda; from the latter he would separate the Arachnida as not having any special connection with the Hexapoda and Myriapoda, the exact relations of which to the other Arthropods is still a matter for speculation. The Arachnida may be divided into three orders: Hæmatobranchia (= Merostomata), Aerobranchia (Scorpions and Spiders), and Lipobranchia (Mites, Pseudoscorpions, &c.).

Function of the Caudal Spine of Limulus.*—J. de Bellesme, after pointing out that this organ cannot, on account of the mode of disposition of the spinules on its lower surface, act as an organ of offence, the need of which, for such a creature, can hardly be imagined, states that the appendage may move vertically through 80°, and that it has a great power of lateral movement. When a King-crab falls on its back, it flexes its prothorax and the tip of the spine touches the ground; the creature now rests on only two points; easily enough it sways to one side or the other till one edge of the carapace touches the ground; all that it then has to do is to alter its centre of gravity by moving its limbs, and it will be found to veritably fall on its feet.

* Ann. Sci. Nat. (Zool.), xi. (1881) art. No. 7, 5 pp.

δ. Crustacea.

Adaptations of Limbs in Atyoida Potimirim.*—This Brazilian fresh-water shrimp to which Dr. Fritz Müller has already † drawn attention in connection with its coloration, is now described on account of the peculiar structure of its first thoracic leg and some other of its appendages. Instead of being constructed, as in the immediate allies of *Atyoida*, ‡ to cleanse the branchial cavity, the appendage mentioned acts as a kind of spoon to provide the mouth with supplies of the fine mud on which this species lives. Whereas in the nearly allied genus *Palæmon*, the "hand" (propodite) is long, and provided with a grasping apparatus in the form of a long slender thumb and movable finger (dactylopodite), in *Atyoida*, the proximal portion of the hand is almost aborted, the finger being articulated to the thumb itself almost in the joint between the hand and carpopodite. The end of each of these parts is provided with a tuft of long bristles, which, when the hand is open, form a kind of fan which detains the fine mud; when the hand is closed the bristles are closed around the mud, compressing it into a pellet, which is passed into the mouth with great rapidity; the same takes place with the three following maxillipedes. Further, the posterior maxillæ, the first and the middle maxillipedes, have each an unusually long and straight inner edge, fringed with bristles of peculiar form, and, in conjunction, forming an organ admirably adapted for receiving the pellets of mud brought in by the legs. The mandibles form a remarkable exception to the rule in the order, in being unsymmetrically developed, a condition which appears to be rather due to preservation of an ancestral character than acquired by adaptation, as the jaws in their earlier stages resemble those of the *Cumacea* and *Amphipoda*.

The 3rd, 4th, and 5th maxillipedes bear the usual appliances for grasping water-plants; but the lower edge of the dactylopodite of the 5th pair is provided with a comb-like appendage for cleansing the abdomen; for this purpose the abdominal appendages are successively bent forward and subjected to its operation, and finally the tail itself. The branchial chamber is cleaned by the 2nd pair of maxillæ, the outer part of which is usually known as the scaphognathite; its epipodite portion, instead of being short and broad, is long and narrow, tapers to a point, and carries a dozen long flexible bristles, and is thus able to reach as far into the chamber as the gill of the 3rd ambulatory leg, and to reach with its bristles to the very extremity of the chamber, and thus to traverse all the surface of the branchiæ.

Another contrivance serving the same purpose, is the set of small sausage-shaped processes which spring from near the anterior edges of the coxopodites of the posterior maxillipedes, and the three anterior ambulatory legs; each process carries about a dozen long hairs and lies back over the coxopodites, and being placed in the entrance to the gill-chamber, hinders, in conjunction with its fellows, the admission of foreign objects. The want of a similar provision in

* Kosmos, viii. (1881) pp. 117-24 (20 woodcuts).
† Cf. this Journal, i. (1881) p. 452.
‡ See this Journal, iii. (1880) p. 63.

the case of the 4th and 5th pairs of legs, is supplied by the remarkable forward projection of the exopodite of the 1st pair of abdominal legs, which plays in front of the space between the last ambulatory leg and the carapace.

As in the case of other shrimps in which the male is not provided with offensive weapons, that sex is smaller than the female; its chelæ are adapted only for prehension of mud; the only appliances by which the female is grasped in copulation are a bent claw on the last maxillipede, and a strong toothed hook on the inner aspect of the tarsi of the 3rd and 4th legs. The *spina pterygostomiana* of the lower edge of the front of the carapace, which has been used as a generic character in *Leander*, is here present only in the adult female; it is thus here merely a sexual distinction; the young females agree, however, with the males in this, and also, owing apparently to their similar proportions, in the number of bristles on the telson.

These numerous peculiarities in the structure of *Atyoida* distinguish it from its allies, *Palæmon*, *Hippolyte*, &c., in the same way as not one but several peculiarities usually separate other species and genera, and also families from each other. The connection between the peculiarities in this case lies in the peculiar mode of life, viz. the use of mud as food-material, and the habit of clinging to plants; which has caused the modification in such an extraordinary manner of the parts concerned in, or affected by these functions.

Colour-sense in Crustacea.*—C. Mereschkowsky has experimented with the view of determining whether the lower Crustaceans distinguish colours.

Larvæ of the Cirrhipede *Balanus* and some marine Copepoda, enclosed in a vessel, seemed fully alive to the difference between light of any kind and darkness; for whereas, in the dark, they were scattered throughout the vessel, they always gathered about a ray of any light coming from a slit. The author considers, however, that it is exclusively the *quantity* of light, not the *quality*, that affects them. Using two slits, one to admit white light, the other coloured, he found that they preferred the former—*all* gathering round it if the coloured light was deep red or violet, and *most* of them if the colour was bright red, yellow, or green. They always preferred a bright light like yellow to a sombre one like violet. When two rays of equal intensity were admitted they gathered in nearly equal numbers about them, whatever the nature of the colours. There is, then, a great difference in the mode of perception of light, between the lower Crustaceans and man, and even between them and ants. While we see different colours and their different intensities, the Crustaceans see only one colour with different variations of intensity. We perceive colours as colours; they only perceive them as light.

Germs of Artemia salina.†—A. Certes has a note on the vitality of the germs of this species and *Blepharisma lateritia*. He states that having evaporated some water and collected carefully the sediment, he three years afterwards heated the residue with boiled

* Comptes Rendus, xciii. (1881) pp. 1160–1. † Ibid., pp. 750–2.

and filtered rain-water. On the following day, and notwithstanding that all care had been taken to keep out germs from the air, Flagellata exhibited themselves; soon afterwards there came Ciliata; about two months later Nauplius-like germs were detected, the number of which rapidly increased, and later on they took on the form of *Artemia salina*. The author points out that, in cases of this kind, death has only been apparent; organic combustion and nutritive changes have not ceased entirely.

A somewhat similar account is given of the rare rose-coloured Infusorian *Blepharisma*.

Vermes.

Origin of the Central Nervous System of the Annelida.*—Prof. N. Kleinenberg gives a summary of the results obtained by him in studying the development of the Polychæta, upon which he proposes hereafter to publish a more extended memoir with figures. At present he confines himself to making known the development of a single species, the larva of *Lopadorhynchus*, until its transformation into the perfect animal.

The most interesting point in the present communication is the discovery of the circular nerve of the vibratile organ of the larva, and the investigation of the development of the central nervous system of the perfect animal. The author has found that during the transformation of the larva into the perfect animal the circular nerve disappears completely, together with the vibratile organ; and the rudiments of the typical central organs are not derived from the transformation of the circular nerve, but originate from other parts of the ectoderm. Consequently the nervous system of an Annelid is not homologous with that of its larva. He thinks that the larvæ of the Annelida possess only the central anterior nervous system of the Cœlenterata, but that the perfect animals have central organs proper to them; so that "the organ of the inferior type originates and functions in the larva, but is eliminated and replaced by new formations in the adult animal."

Swim-bladder-like Organs in Annelids.†—Dr. H. Eisig states that in preserving specimens of *Hesione sicula*, he has often observed a considerable number of air-bubbles escaping from the mouth or anus; by this and by the observation that in some cases specimens of the same Annelid are found passively floating on the surface of the water in which they were placed, he was led to the discovery that two contractile appendages communicate with the intestine, and that these must be regarded as the reservoirs of the gases; according to their condition they may appear as inconsiderable diverticula or as distinct bladders; he explains the fact of their being overlooked by previous observers as due to their ordinarily empty condition after death. On examining specimens of *Syllis aurantiaca* it was found that the so-called T-shaped glands of the Syllidea are swim-bladders.

* Atti R. Accad. Lincei, Transunti, vi. (1881) p. 15. See Ann. and Mag Nat. Hist., ix. (1882) p. 67.

† MT. Zool. Stat. Neapel, ii. (1881) pp. 255–304 (3 pls.)

When a detailed examination is made of *H. sicula* it is found that the enteric tract may be divided into (*a*) a proboscis with an œsophagus, (*b*) the proper digestive gut, and (*c*) an intermediate fore-stomach to which the bladders are attached. The first and last portions of the gut (*a* and *b*) differ not only in external appearance, but also in structure; while in the former the epithelium is feebly developed, in the latter it gives rise to a well-developed mucous membrane; the constituent cells are greatly elongated and are ciliated at their free extremity; it is also richly supplied with blood-vessels which, as in the clitellum of the Earth-worm and the epithelium of the Leech (Lankester), interpenetrate between the cells; this rare and remarkable arrangement would appear to be explained by the fact that in the *Hesione* (as in *Syllis*) the gills are absent.

The fore-stomach has very thin walls and when contracted is hardly of the length of a somite; it is, however, capable of great extension; in its structure it is intermediate between the œsophagus and the gut proper; for, while it resembles the former in the characters of its epithelium, it has the musculature of the latter. At its side the two bladders open. Till they approach their orifice these bodies have a ventral position, they appear to be easily contractile and of great extensibility. When full they form saccular reservoirs; when empty cylindrical tubes, which gradually diminish in diameter towards their blind end. Their orifices are wide, but there is a means by which food is prevented from entering them, and the valvular arrangement is such that, the mouth or anus being closed, gas or water enters them where the gut contracts, and water or gas passes from them into the gut when they contract. In general structure they resemble the fore-stomach, of which therefore they may be regarded as diverticula.

On examining the characters of the blood-vascular system we see a dorsal double trunk, a ventral single, and two lateral ones; the two former, by numerous anastomoses, carry venous blood to the walls of the stomach, whence it passes to the lateral trunks; these are of considerable size and contract rhythmically and supply the greater part of the body by the thirteen arteries which are given off from them to as many somites. The ventral and the lateral vessels are also in direct connection by several anastomoses, and each artery is likewise in communication with the ventral enteric vessel. In other words, the greater quantity of blood is brought into connection with the intestine.

Other Hesionids and the Syllidea are then described; after which the author passes to a consideration of the function of the swim-bladders; these were never found to contain food or to give rise to any secretion; they contained nothing but a varying amount of clear fluid and gases, both of which could be driven into the stomach, or *vice versâ*. The fluid is sea-water, taken in from without, and this water appears to be taken in for respiratory purposes. As to the "air," experiment first of all showed Dr. Eisig that it was not atmospheric air, and the question whether it was secreted in the animal itself was examined, after the following considerations; the air-bladders are thin-walled, elastic, and without blood-vessels; the gut has

thick glandular walls and is richly supplied with blood; it is, then, the prime seat of the respiratory processes. As it was impossible to examine the small quantity of gas, the question of its real character could not be decided by chemical analysis, but the author concludes that it is oxygen secreted from the mucous membrane of the stomach; and as the bladders cannot be supposed to have any hydrostatic function, he thinks that they are truly reservoirs of oxygen, which can be called upon at periods of digestion and so on, when the animal is unable to take in a quantity of fresh sea-water to aerate the blood which is passing in such quantities through the walls of its stomach.

As to the morphological significance of these appendages which have already been shown to be diverticula of the fore-stomach, we find them to be, in all probability, a product of the endoderm. The variations in its development which are to be seen among the Syllidea, with the general characters of *Syllis*, and the absence of any special enteric vascular system in *Tyrrhena*, lead to the conclusion that the atrophy of the bladders in some of the Syllidea is due to the development of the dermal mode of respiration. In all Annelids in which gills are wanting, and these gills are no peculiar developments, an enteric mode of respiration would appear to obtain. We may, in conclusion, suppose that, in the ancestors of the Fishes of the present day enteric respiration existed (as it does to this day in *Cobitis*); in some this mode led to the formation of a reservoir, which under hydrostatic influences took on the function of a hydrostatic organ. At the present day we see that a fish uses up all the air in its air-bladder before it is suffocated, and even that a pulmonate Vertebrate uses its lungs, in water, as a hydrostatic organ.

Development of Polygordius and Saccocirrus.*—W. Repiachoff finds that in both these lowly Chætopods the cleavage of the ova is total; that after eight segments have become developed the embryonal cells begin to develope one after another; the gastrula is formed by invagination; while the mesoblast of *Polygordius* appears to be developed from the hypoblast, in *Saccocirrus* "primitive mesodermal cells" are to be found within the cleavage cavity. Even during the blastula-stage the embryos of *Polygordius* begin to swim about by means of very fine cilia; after the closure of the blastopore the larva becomes more vermiform; the now-closed anterior end remains, however, for some time distinctly swollen out. Movable hairs appear at scattered points on the surface of the larva, which give to the creature something of the appearance of a larva of *Sagitta;* later on, two cirri become developed at the anterior end, but this species of *Polygordius* (*P. flavocapitatus*) never passes through the stage of the Lovenian larva.

Termination of Nerves in the Voluntary Muscles of the Leech.†—A. Hansen states that the nerves divide and subdivide without forming anastomoses, and lose themselves in the muscles without our being able to discover their terminations; in only one

* Zool. Anzeig., iv. (1881) pp. 518–20.
† Arch. de Biol., ii. (1881) pp. 342–4.

case was such a termination even unsatisfactorily observed. From a common trunk composed of several fibres one separated and ended at a muscle; here it divided into two fibrils, which each terminated in a muscular fibre, where it formed a kind of motor plate; the arrangement, therefore, was very similar to that described by Ranvier for the muscles of the stomach, from which it differs only in the somewhat larger size of the plate.

The Echiurida.*—Professor R. Greef is of opinion that there is no close genetic affinity between the Gephyrea and the Echinodermata, but that the former represents a distinct class allied to the Annelids and divisible into an armed (Echiuridæ) and unarmed (Sipunculidæ) group.

In this elaborate monograph he deals, after an historical and a bibliographical introduction, with (1) their distribution, which appears to be very wide, though *Bonellia* is confined to the Mediterranean area, and *Echiurus* to the northern side of the equator. Their coloration can only be made out in the fresh condition as the pigment is soluble in alcohol. The various organs are dealt with in order; the presence of a central canal in the nervous system is noted, and it is suggested that it is a remnant of the ectodermal invagination; fluid is to be found in this canal. A full account is given of the curiously minute male of *Bonellia*. The essay concludes with a systematic definition of the family, and of the three genera and fifteen species of which it is composed.

Segmental Organs and Genital Gland of some Sipunculida.†—Dr. C. P. Sluiter discusses the question whether the so-called brown tubes have or have not an opening into the cœlom; after having had the opportunity of examining a number of fresh tropical forms, he has almost always been able to detect an orifice, which, however, was not, as is ordinarily stated, placed near the anterior, but just beside the posterior end of the tube; in only one case was the orifice anterior and then there was an infundibular structure developed which communicated by the funnel with the interior of the tube; the funnel proper consists of four lobes, two larger lateral, and a small dorsal and a small ventral; about the middle of the funnel the lobes fuse with one another to form the tube. In some few cases the author was unable to observe either an anterior or a posterior orifice; this was in forms in which the longitudinal musculature was not differentiated; the wall of these brown tubes is, however, extremely thin, and can be easily ruptured. In structure the walls generally exhibit a circular and a longitudinal layer of muscles, and a series of radial glandular tubes. The author describes the generative organs, and finds that the glands form sausage-shaped structures in a deep groove between the dorsal retractors; these bodies have a wall of fibres of connective tissue which extends and is attached to the wall of the exterior; the inner side of this wall is invested by a layer of small mother-cells from which egg-cells are regularly given off. In other forms the

* Nova Acta Acad. Cæs. Leop.-Carol. Germ. Nat. Cur., xli. ii. (1880) pp. 1–172 (9 pls.).

† Zool. Anzeig., iv. (1881) pp. 523–7.

generative glands formed ridges of connective-tissue fibres which did not form rounded bodies, but widely open grooves which extended between the muscles; on the inner face there is again a layer of mother-cells, which give rise to egg-cells. The male organs were only once observed, when they were seen to present all the essential characters of the female.

Anatomy and Histology of Sipunculus nudus.*—Dr. J. Andreæ here gives a full account of his investigations, the preliminary notice of which we have already noted.† With regard to its external form, he points out that, owing to its rich supply of muscles, the integument is highly contractile and that consequently the creature can, and does, take on the most various forms. The cuticle is thin, transparent, and so arranged as to be iridescent during life; the pores of the glands are irregularly distributed over the whole of the body, and vary in size according to the size of their glands. The pigment-spheres have been but rarely noticed, although they are widely distributed over the body; varying much in dimension, they are seen in sections to be provided with a doubly contoured covering, within which there is a brown granular mass, containing a number of elongated oval nuclei. The circular musculature of the body does not consist of a continuous layer, but of a number of flattened broad bands, the space between which altogether disappears when the animal contracts in diameter. In addition to these and the longitudinal muscles there is a much more delicate layer of diagonal fibres, more widely separated from one another. The walls of the tentacles are a direct continuation of the proboscis, and within there is a cavity connected with the circumpharyngeal vessel. The value of the integumentary cavities as the seats of respiratory activity is insisted upon, as is the fact that the ventral cord, unlike that of Annelids, is single and not double; the cord, further, presents no ganglionic swellings except at its termination, though, owing to its form, there would, on superficial examination, appear to be such. The supra-œsophageal ganglionic mass is biscuit-shaped, and presents distinct indications of having been originally double; like the ventral cord, it is traversed by a network of connective-tissue fibres, and the ganglia are most largely present on the ventral surface of the two spheres, on the anterior margin of the projection, and at the tip of the finger-shaped processes which are given off from it.

The author is of opinion that the group of the Gephyrea is a natural one, that it stands closest to the Annulata, and that it is justifiably divisible into the two orders of the Sipunculida and Echiurida.

Sternaspis.‡—In this elaborate monograph the structure and development of this Gephyrean is very fully treated by Dr. F. Vejdovsky. He distinguishes a fore- and a hind-body, and recognizes seven segments in the former and a varying number in the

* Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 201–58 (2 pls.).
† See this Journal, i. (1881) p. 892.
‡ Wien. Denkschr., xliii. (1881) pp. 33–90 (10 pls.).

latter, from eight to twenty-two being there developed; but in their case the intersegmental grooves are not found at the sides of the body; they are all provided with a single lateral row of setæ. The hindermost part of the body is characterized by the presence of a ventral shield which on the ventral surface takes the place of a number of segments. The gill-filaments are spirally coiled and form two dorsal pre-anal tufts. On examining the dermo-muscular tube it is found that the hypodermis in the median segments forms a homogeneous layer, here and there traversed by fine fibres of connective tissue, but altogether devoid of the unicellular glands which are so frequently found in this layer in Chætopods and other Gephyreans; the structure of the hypodermis in other regions is also described. The cuticle is much thicker at the posterior than at the anterior end of the body and is thicker than in any other Gephyrean or Chætopod known to the author. The cross-bands found on it seem to prove that in life the cuticle must be intensely iridescent. The surface of the cuticle is covered with special dermal cirri, which are continuous with the subjacent layer by dermal pores; these cirri are filamentous and vary in form in different parts of the body; capillaries have been observed in some of them, and there seems to be no doubt but that they have a respiratory function.

Sternaspis is distinguished from all other Gephyrea and Polychæta by the peculiar disposition of its setæ, which fall into three different groups, the arrangement, muscular supply, and development of which are fully described.

The cerebral ganglia occupy the whole of the cephalic lobes; the ganglion-cells occupy the upper, lateral, and basal parts, while the fibrous substance lies between them; there is still a close connection with the ectoderm. The greater part of the brain consists of cellular elements, which exhibit distinct bilateral symmetry; the cells vary greatly in form and size. The two bands of the œsophageal ring are proportionately long, and consist of fine nerve-fibres, without any ganglion-cells. The ventral cord is regularly rounded, and at first lies freely in the cœlom; it then runs between two bands of longitudinal muscles, without giving rise to any ganglionic swellings till the end of the body is reached; the complicated arrangement of the cells and fibres in the cord was made out by the aid of sections. Comparing this system with that of allied forms the author finds it to be intermediate between what is found in Gephyrea and Chætopods. On the other hand, in the character of the enteric canal *Sternaspis* stands nearer the Gephyrea than the Chætopods.

The vascular system is very complicated; in addition to the two primary vessels, or hearts, there are a number of lateral vessels, which form remarkably close plexuses in all the organs, and there is also a special branchial system. There appear to be a pair of lateral vessels for each segment of the body. The segmental organs form a pair of brown bodies lying on either side of the œsophagus in the fifth and sixth segments; they are of a spongy texture and may be seen to contain a quantity of refractive concretions, which prove their renal function; they have no external orifices. The sexes can only be distinguished

from one another by the reddish colour of the ovaries, and the whiteness of the testes. They lie in the coils of the enteric canal, and are in both cases provided with a pair of ducts, which open to the exterior between the seventh and eighth segments. No directive corpuscles could be observed in the mature unfertilized ova. The ducts of *Sternaspis* appear to be special structures and not modified segmental organs. The cleavage of the egg appears to take place rapidly, inasmuch as after sixteen hours there are seen ciliated embryos; the whole of the body, with the exception of the hinder end, is covered with very fine cilia, and a tuft of longer ones is seen at the anterior end. The embryo gradually grows narrower posteriorly, and the porous cuticle corresponds exactly to the yolk-membrane, which seems to grow with the body. The anterior end becomes divided into three lobes, of which the median is the largest. At this period the endoderm fills up the whole of the tube formed by the ectoderm, and, so, exactly resembles the *Planula* of the *Hydromedusæ.* After forty-eight hours the larvæ are twice as large, have lost all their cilia, and have the form of a non-ciliated Turbellarian without mouth or anus. A new cuticle, which has very much the appearance of a former one, is developed over the whole of the body; the ectodermal cells become much more distinct, and those of the endoderm begin to indicate the formation of the enteric tube. At the hinder end of the body the two layers are now separated and the intermediate space is occupied with spindle-shaped nucleated elements, which perhaps owe their origin to the endoderm. After five days the cephalic lobes appear, and the mesoderm is found to have given rise to muscle-cells. On the sixth day, when the observations ceased, the excretory canals began to appear.

In conclusion, the author thinks that there are four natural orders of the class Annelides : (1) *Hirudinea ;* (2) *Oligochæta ;* (3) *Polychæta ;* and (4) *Gephyrea.* In a phylogenetic table he shows that he would derive the first two from the *Discodrilida*, and the other two from *Sternaspis ;* the Discodrilida form an offshoot from the Oligochæte stem which descends into the Amedullata, which, with *Sternaspis*, have their common origin in the Turbellaria, which, for their part, are derived from the Cœlenterata. The Polygordiidæ (*Achæta* Balfour) seem to Dr. Vejdovsky to form a group of the Polychæta.

The author believes that the larvæ of the Chætopods and Gephyrea are formed on the same type, and that in *Echiurus* there is a true segmentation of the body.

Hamingia glacialis.*— In his detailed account of this new Echiurid,† Dr. R. Horst points out that the digestive tract presents a number of coils, that the mouth forms an elongated cleft, and that the conical pharynx is separated by a constriction from the œsophagus; this latter is somewhat pushed to the right side owing to the great development of the uterus. The vascular system possesses a ventral vessel which accompanies the ventral end, along its whole length; a dorsal vessel which does not extend over more than half of the body,

* Niederl. Arch. f. Zool., Suppl. Bd. i. (1881) 1st art., 12 pp. (1 pl.).
† See this Journal, i. (1881) p. 891.

and a neuro-intestinal anastomosis, by means of which the two primary trunks communicate with one another. The ovarian tubes agree generally with those of the other Echiuri, and the tubes, being in the specimen examined filled with ova, had a yellowish colour. Just as in *Echiurus*, the proper covering for the egg which is found in *Bonellia*, is completely absent. The author is unable to make any statement as to the male organs.

Echinorhynchus.* — P. Mégnin states that the menisci of this parasite open at the base of the proboscis by a large buccal pore; in *E. brevicollis* the menisci are replaced by two long cylindrical tubes which open into a groove at the base of the proboscis, and extend as far as the hinder extremity of the body; they are clothed internally by polygonal cells, and the whole arrangement strongly calls to mind the bifurcated intestine of some Distoma. This intestine, which is to be seen in encysted larvæ and, undergoing atrophy, is only represented by the menisci in the adults of most species, persists in certain forms. The author thinks that this arrangement indicates some affinity of the Acanthocephali with the Trematoda, and separates them from the Nematodes, with which order they are frequently placed.

Proscolex of Bilharzia hæmatobia.†—J. Chatin states that the ovum is regularly oval, and has a kind of apical tubercle at one pole, a character which is extremely rare among the Trematoda digenea, though common enough among the T. monogenea. The infusoriform character of the larva is pointed out, and the anterior end is stated to become shortly differentiated into a cæcum which projects into the body-cavity, and which the author, agreeing with Dr. T. S. Cobbold, looks upon as being the first rudiment of the digestive tract. This being, then, possessed by the larval form, it should rather be spoken of as scolex (Rédia) than as proscolex; and this view would be strengthened by the certainty of the sarcode spherules being, as the author thinks they are, young gemmæ in course of development. These amœbiform bodies are shown not to have the special outer layer of the simpler organisms (Amœbæ), but rather a cuticle distinctly differentiated, and not unlike the protecting layer which we find on the young Cercariæ developing within a sporocyst or a Rédia.

Nervous System of Cestoda.‡—In the third part of his account of his investigations into this system of the Platyhelminthes, Dr. A. Lang deals especially with the Tetrarhynchi, which he chose on account of the notorious difficulties which are associated with the investigation of the Tæniadæ, and because of the promise of a well-developed nervous system given by the large amount of muscular tissue in the scolex, and of the large size of some of the species. Difficulties, however, were not evaded; nothing of value can be obtained by maceration, and nothing at all by examination of living specimens. Transverse sections carefully made gave good results.

* Comptes Rendus, xciii. (1881) pp. 1034–6.
† Ann. Sci. Nat. (Zool.), xi. (1881) art. No. 5, 11 pp. (1 pl.).
‡ MT. Zool. Stat. Neapel, ii. (1881) pp. 372–400 (2 pls.).

The following forms were examined :—(1) *Rhynchobothrium corollatum*, from the intestine of *Mustelus levis;* (2) Scolices of *Tetrarhynchus*, from the muscles of *Orthagoriscus mola* (probably *T. gracilis*); (3) *Anthocephalus elongatus*, from the liver of the same fish; and (4) *Anthocephalus reptans*, from *Symnus lichia.*

The scolex may be divided into three parts: (*a*) a cephalic region, which carries the sucker; (*b*) a cervical region, containing the sheaths of the proboscis; and (*c*) a bulbous region, which carries the swellings of the proboscis. In the first of these we find in the more anterior sections four outer cephalic and four inner cephalic nerves; in the succeeding sections these eight nerves are thicker and more distinct, two are now approaching the region of the cerebrum; in the next section we find on either side a commissure between the upper and lower internal cephalic nerves; then one between the upper and lower outer nerves; within these commissures there are small bipolar ganglionic cells with a large nucleus and a distinct nucleolus. The inner cephalic nerves give off smaller ramules.

Further back, not only are the four upper connected by commissures with the four lower nerves, but the two inner, on either side, are connected by a transverse band with the two outer. From the outer angles of the squarish mass thus formed a strong nerve is given off which passes to the sucker. As yet, the two halves of the cerebrum appear to be independent; but, further back, there are two connecting commissures. Still further back sections are found to exhibit a united transverse commissure, which gives rise to a band-shaped cerebral mass, enlarged towards its middle and at either end.

The author then compares this account of what obtains in *T. gracilis* with the arrangements which are found in the other forms that he examined.

Passing to the cervical portion of the scolex, we find the two longitudinal trunks which arise from the brain; they lie, on either side, within the dermo-muscular tube, between the ascending and descending water-vessel. Here and there they give off delicate nerves which, generally, pass off to the dermo-muscular tube. The author directs attention to the presence of a somewhat disturbing element on the inner side of the nerves; these appear in section as dotted masses; they turn out to be the united efferent ducts of the large number of gland-cells which are imbedded in the parenchyma of this region of the body.

In the bulbous portion the longitudinal nerves present much the same arrangement as in the cervical part, and the chief interest centres in the branches which are given off from them; the separate fibres of these enlarge here and there into very long and large ganglion-cells. In the proglottides the lateral nerves extend to the end of the chain, retaining their former relative position; they are best developed in the more anterior joints, in which the generative organs are still feebly developed. Towards the hinder end they become more indistinct.

After some critical remarks on the observations of earlier observers, the author passes to *Amphilina*, an unjointed Cestode; the spongy

cords which Salensky, following Sommer and Landois, regarded as water-vessels, are regarded as true nerves; in longitudinal sections their course can be easily followed; the longitudinal nerves extend through the whole of the body and unite at the posterior end. They give off outwards at short distances small ramules, which probably innervate the dermal musculature, and they also occasionally give off internal branches. Some little way behind the anterior end of the body the nerves give rise to a small thickening, which becomes united by a commissure with its fellow of the opposite side. From the thickened ends of this cerebral commissure a well-developed nerve passes forwards, to supply the most anterior end of the body and the muscular walls of the sucker. There is, on the whole, a not inconsiderable resemblance to what obtains in the Trematoda.

In conclusion, Dr. Lang sums up the state of our knowledge as to the nervous system of the other Cestoda: *T. perfoliata* has a better developed nervous system than the rest of the Tæniadæ; the anastomosis or cerebrum contains nuclei and fibrils, gives off two lateral primary trunks, and completely resembles in structure the same parts in the Nemertinea; *T. solium*, with others, has three cords on either side. In the Bothriocephalida the water-vessels are on the outer side of the longitudinal nerves, and here also the anastomosis is concave anteriorly; in the Ligulida the connecting commissure forms a pretty broad bridge, the lateral trunks lie outside the water-vessels, and are approximated towards one another in the anterior region of the body.

Development of the Ovum of Melicerta.*—L. Joliet points out that the development of the embryo of Rotatoria has as yet been studied in only two genera—*Brachionus* by Salensky, and *Pedalion* by Barrois. The mode of segmentation is still unknown.

Although the author has ascertained † that the development of the winter-egg and of the male egg agrees in a general manner with that of the female summer-egg, it is more especially on this last that his researches have been made.

Within the maturation-sac it presents, in the middle of the germinal vesicle, a small but very distinct germinal spot. After deposition this spot speedily disappears. It did not appear to the author that there was any emission of a polar globule. The first segmentation-plane perpendicular to the major axis of the egg, which is an irregular ovoid, divides it into two very unequal segments. Afterwards the two segments divide symmetrically, and so that each furnishes eight of the spheres which constitute the egg in the stage xvi. The spheres derived from the larger primary segment are larger than the others, and also larger in proportion as they are further from the animal pole. Each would appear to have, so to speak, a certain degree of animality. Throughout the whole duration of the segmentation, the part played by the nuclei and the asters is very remarkable. A rotatory movement, already noted by Barrois in *Pedalion*, is

* Comptes Rendus, xciii. (1881) pp. 856–8.
† See this Journal, i. (1881) p. 894.

also observable, which tends to transport the spheres derived from the small segment from the animal pole to the opposite one, skirting the dorsal face, while the large spheres give place to them and glide along the ventral face.

At the stage xvi. the egg is composed of a row of four small cells derived from the small segment and occupying the dorsal face, of four spheres, larger and larger, occupying the ventral face, and of two rows of four cells placed on the sides, and four derived from the large and four from the small segment.

It is only after this stage xvi. is reached that the dorsal and lateral cells commence to multiply much more rapidly than the ventral ones, and to spread over their sides. In proportion as these small cells glide over the surface of the large ones, the latter sink with an oscillatory movement, which at first removes the smaller ones, until at length the last and largest glides in its turn under the first, leaving an orifice, the blastopore, which remains visible for some time almost exactly at the spot where, later on, the mouth is formed.

By the very place which it occupies from the moment of the closing of the blastopore, it is easy to see that the last sphere enveloped corresponds to the intestine, which it will serve to form, if not entirely, at least in great part.

In the same way, by the manner of their inclusion, the two large spheres following will be on the ventral face of the first, in the situation which the genital organs will occupy. Later on, when the spheres begin to divide and subdivide, this disposition becomes very obscure; but for a certain time after the closing of the blastopore it remains perceptible, and shows that the embryo is formed, if not of continuous layers, at least of masses of tissue which obviously correspond to the endoderm, mesoderm, and ectoderm of the higher animals both in their position and destination.

When the subdivision has been pushed to its furthest limit the egg presents the form of a finely moruloid mass, in which can only be recognized an outer light layer and a darker central one. The cephalic region always remains lighter. The blastopore is no longer distinguishable.

Soon, along the side and ventral face an oblique furrow appears which constricts the mass and separates the tail; the latter is thus folded under the ventral surface and directed towards the head, as in the embryo of *Brachionus* and *Pedalion.*

About the level of the caudal extremity a depression appears in the cephalic mass; it is uncertain if it corresponds to that described by Salensky in *Brachionus*, but it indicates the appearance not of the mouth but of the vibratile pit situated under the lip in the adult. A little later, and somewhat higher up, the mouth appears, as a depression sufficiently sunk, without doubt to form the mouth, but certainly not sufficiently to form the mentum. Yet later, and also on the back, the cloaca is formed by an invagination of the ectoderm, and this, though very long in the adult, is as yet very short in the larva, and remains reduced to a simple emargination in the Flosculariæ. The cephalic region is soon defined by a slight fold, which

indicates the margin of the chitinous covering. The eyes appear as two red points; cilia commence to move, at first on the infra-buccal pit, then on the mouth, and finally on the top of the head, where they form a circlet. The armature of the mastax comes into existence, the tail retires little by little towards the extremity of the egg, whose envelope it finally ruptures. The larva has been already described by several authors, and M. Joliet only insists on the fact that, like the larva of *Lacinularia* figured by Huxley, it presents cilia on three parts of its body; a continuous, and at this time scarcely sinuous circlet placed above the mouth; a second circlet surrounding this and the mouth, stretching even over the vibratile pit; lastly, a tuft of cilia at the extremity of the tail. The larva remains active for some hours, and then becomes fixed by means of the glands enclosed in its tail. It then commences to collect in its vibratile pit the minute particles held in suspension in the water, mixes them with the secretion from the gland, hitherto taken for a ganglion, and, according to the judicious observations of Gosse and Williamson, therewith forms the pellets which, when juxtaposed, constitute the tube it inhabits.

Echinodermata.

Development of the Skeleton of the Ophiurida.* — The first point to which Prof. H. Ludwig addresses himself is the development of the arm-ossicles; these he has previously stated to be originally double, but he has never till now been able to demonstrate this by a reference to embryological data, though the discovery by Lyman of deep-sea forms in which these ossicles were distinctly double has afforded considerable support to Dr. Ludwig's doctrine. The form best adapted for investigation is the viviparous *Amphiura squamata.*

As is well known, the arms of the Ophiurid grow at the tip; the first rudiment of the ossicle consists of two calcareous pieces symmetrically placed on either side of the middle line of the arm, and each has somewhat of a triangular form; one ray is directed aborally in the long axis of the arm, the other two look adorally, and form between them a smaller angle than each of them forms with the aboral piece; these two do not, however, lie in the same plane, but one is dorsal and the other ventral, the former being further median and the other lateral in position. At an early period a distinct difference may be seen in the size of these three rays; the aboral becomes longer than the adoral rays; the form of the whole piece changes, owing to the development of calcareous processes, which sooner or later fork at their free end, and become connected with the ends of neighbouring forks, so as to give rise to the reticular tissue characteristic of the Echinodermata. In this way the two adoral pieces become connected together. Soon, too, the aboral process begins to form meshworks. This mode of growth not only takes place laterally but also mesially, so that the ends of the adjoining ossicles come into direct contact, without, however, fusing. Later on, this fusion commences both at the aboral and adoral ends: in their middle there is a space with concave sides, which only becomes completely filled up at a later stage.

* Zeitsch. f. wiss. Zool., xxxvi. (1881) pp. 181–209 (2 pls.).

The relations of the ossicles to the radial water-vessel and its lateral branches are, further, of special importance; this vessel lies, from the first, ventrally to the rudimentary ossicles, and it is only after some time that the branches to the feet become surrounded by calcareous tissue; in other words, the branches of the radial vessels have at first the relation which they retain throughout life in the Asteroidea.

After some further consideration of these points, the author passes to the terminal plate of the arm, as to which he has convinced himself of the accuracy of J. Müller's doctrine that this piece has primarily a groove on its lower surface, and that it is only later on that it becomes converted into a ring. The later observations of Prof. Ludwig have convinced him of the accuracy of his comparison of the lateral plates of the arm of an Ophiurid with the adambulacral pieces of an arm of a star-fish.

The ventral plates are reported to commence as a small tri-radiate body lying exactly in the middle line of the arm, with one aboral and two adoral rays; these, then, notwithstanding opposing statements, are unpaired pieces. The same is true of the dorsal plates.

The interesting oral pieces of the skeleton are truly the modified first ambulacral pieces; a young *Amphiura* exhibits the possession of nine skeletal pieces for each ray; one of these is terminal and unpaired, the other eight lie in four pairs symmetrically on either side of a middle line; of these two, more feebly developed, lie closer to the median plane of the radius, and more deeply in the body; the other two are better developed, and lie more superficially; the former are the first two ambulacral, the other the first two adambulacral pieces. The second pair of ambulacral pieces becomes more strongly developed than the first pair, the two pieces of which, later on, form thin calcareous plates, which descend further and further into the angles of the mouth, remain separated from one another, and, still later, give rise to the two peristomial plates. The second pair unite together and become connected with the first adambulacral pieces to form the *tori angulares.*

The first skeletal pieces to appear on the dorsal side are the five terminal plates of the arms; internally to them come the five primary radials; the central piece usually appears later on; the intermediate skeletal plates appear around the central. The so-called radial shields of the adult appear early at the outer edge of the radials. The author points out the similarities in position between the primary madreporic pore of *Amphiura* and the corresponding structure in the larva of *Antedon.*

Asterias.*—In the first part of his 'Contributions to the Systematic Arrangement of the Asteroidea,' Prof. F. Jeffrey Bell discusses the species of the genus *Asterias;* after giving a list of the 77 known species, and of the 34 well-recognized synonyms, the author proceeds to suggest an arrangement for breaking the species up into groups; He first separates the species "into those in which there are developed

* Proc. Zool. Soc. Lond., 1881, pp. 492-515 (2 pls.).

more than five rays, and those in which, so far as we know, the number five is constantly retained." For these two groups the terms *Heteractinida* and *Pentactinida* are suggested. Among the former we find that some of the species have more than one madreporic plate; the secondary divisions, therefore, are named *polyplacid* and *monoplacid*. The value and character of the number of rows of adambulacral spines is next discussed, and the terms *Monacanthida*, *Diplacanthida* and *Polyacanthida* are applied to the forms in which there is one, two, or more than two such rows. Some species are shown to have their madreporic plate encircled by spines, and these forms are distinguished as being *echinoplacid*. The next character used depends on the arrangement of the spines, "on special local modifications of the integument, which may be known as special plates"; such forms are *autacanthid;* those in which the more ordinary arrangement obtains are known as *typacanthid*. The last character used for the formation of small groups depends on the form of the spines on the abactinal surface; and here we have *simplices*, *rarispinosæ*, *obtusispinosæ*, and *acutispinosæ*.

After a table, in which this system of grouping is worked out, the author passes to the "mode of formulating results," using a certain number of symbols, and distinguishing heteractinid from pentactinid forms by placing over their formulæ the mathematical sign of the square root. Short formulæ are given for most of the known species. Thus, for the well-known *A. rubens*, we have the formula 2 *ats*, for it is diplacanthid (2), anechinoplacid (*a*), typacanthid (*t*), with simple dorsal spines (*s*). Again, $\sqrt{1\,p}$ is sufficient to distinguish *A. calamaria* as a monacanthid, polyplacid, heteractinid form. "If we know, as we do in this case, further details, we may write the formula $\sqrt{1\,paa'}$; or, in other words, in addition *A. calamaria* has no spines round its madreporic plate, and the dorsal spines are placed on special plates."

The author then makes some observations on the species of *Asterias*, found in the British seas, and concludes with the description of five new species: *A. philippii*, *A. inermis*, *A. verrilli*, *A. spirabilis*, and *A. rollestoni*, for all of which, as also for *A. japonica*, of which a description is given, the author gives the "general formula."

Spines of Asteroidea.*—At the conclusion of a description of a new species of *Archaster* (*A. magnificus*), Professor F. J. Bell points out that in littoral species, at any rate, the strength and number of the spines is in inverse proportion to the stoutness of the skeletal plates; when these are strong the star-fish is enabled to withstand the bite of an enemy; but when they are weaker, a defensive apparatus is provided in longer, stronger, and stouter spines.

Cœlenterata.

Prodrome of the Anthozoan Fauna of Naples.†—Dr. A. Andres here gives a systematic catalogue of the species, with synonymy, &c.,

* Ann. and Mag. Nat. Hist., viii. (1881) pp. 440–1.
† MT. Zool. Stat. Neapel, ii. (1881) pp. 305–71.

an alphabetical index of species and synonyms, a bibliographical list, and an index of authors.

Metamorphoses of Cassiopeia borbonica.*—Professor G. Du Plessis has observed ova of what he believes to be this species, develope into a fixed Scyphistoma, after passing through a free Planula-stage. Other larvæ of similar appearance, which had already attained the Scyphistoma-stage, were studied by him at the Naples Aquarium, and were seen in the middle of October to divide metamerically into segments, forming the well-known Strobila-stage. The segments soon became detached, constituting free Ephyræ of a similar, but paler, yellow tint to that of the adult of the above species, but differing from it in having four simple and suckerless, instead of eight ramified arms, and in having the margin of the umbrella much more deeply notched. In this instance also, the attempt to rear the adult failed, but as the only other species whose stages resemble these, has quite a different Ephyra, there seems good ground for believing that we have here the full metamorphosis of a Medusa, supposed hitherto to develope ametabolically. In the agreement of its physiological arrangements with those groups with which it has hitherto been classed, it affords an argument in favour of the morphological correctness of the present classification.

Development of Geryonopsida and Eucopida.†—Professor C. Claus states that in an aquarium containing sexually mature specimens of *Octorchis gegenbauri*, *Irene pellucida*, and *Æquorea forskalea*, he saw small polyp-stocks which presented great resemblance to *Campanulina;* the elongated hydranths were placed on branched stolons, the periphery of which was invested by a more or less distinct periderm. There was a conical retractile proboscis, and the base of the contractile tentacles was surrounded by a delicate ectodermal fringe. Hydrathecæ were, however, altogether wanting; this and other differences induce the author to call this form *Campanopsis*. The medusa-buds arise on the middle of the body of the polyp, where they form one, two, or, rarely, three transverse rows; they appear as bilaminate rounded projections, the base of which soon grows into a long cylindrical stalk, with a vesicular endoderm. Before the formation of the subumbrellar cavity, the ectoderm gives rise to a layer of flat cells, which form the theca, and give rise to a closed mantle-covering. The manubrium is formed from a central elevation; the radial vessels give rise to outgrowths, which are the rudiments of the primary marginal tentacles. In alternate rays, as well as between these and the primary tentacles, marginal vesicles become developed with small intermediate thickenings—the rudiments of fresh marginal filaments. When, therefore, the medusa is set free, it has two long tentacles and eight adradial marginal auditory vesicles. These last, which are relatively large, contain each a single otolith. At this point, unfortunately, the author's direct observations cease, but he adduces reasons for believing that this *Campanopsis* is an *Octorchis*.

* Bull. Soc. Vaudoise Sci. Nat., xvii. (1881) pp. 633-8 (1 pl.).
† Arbeit. Zool. Inst. Wien, iv. (1881) pp. 89–120 (4 pls.).

In some notes on the development of *Irene pellucida*, which is so common in the Adriatic from October to March, Claus states that it is possible that the polyp-form of this Medusa is a *Campanulina*. The first rudiment of the tentacles appears as an outgrowth, presenting brownish granular concretions, and having a pore at its tip; these pores are looked upon as being the orifices for subjacent glands, which probably have the function of renal organs, and which are formed by the endodermal investment of the adjacent portion of the circular vessel; by direct observation one may convince oneself that the brown granules and refractive concretions do escape by these pores to the exterior. The genital products appear to become matured in specimens of very various sizes. Some notes on *Phialidium variabile* complete the paper.

Fission of Phialidium variabile.*—Dr. M. Davidoff states that he has observed in this Leptomedusa that a second stomogastrium becomes formed at the base of the stomach as a small downwardly projecting bud; this happens before the tentacles are all developed. The bud gradually grows, and after some time a mouth breaks through. The whole medusa now commences to elongate, and the stomogastria occupy the centres of the ellipse; two radial canals now open into each stomach and between the two mouths there is an intergastral canal. After these and other changes are effected, the creature is ripe for fission; the plane of division lies between the two stomogastria, and almost always at right angles to the long axis of the ellipse; the constrictions deepening, the medusa is divided into two nearly equal halves. In some cases there is a third stomogastrium developed. The author reminds us that Kölliker, many years ago, noticed a process of fission in *Stomobrachium mirabile*.

Crambessa tagi.†—Professor R. Greef points out that this Portuguese Medusa affects the mouths of rivers, and makes its way into landlocked bays. He has found a wide vessel running within the oral fold; the two pairs of vascular branches which are given off from the short central transverse vessel, open, together with the eight arm-vessels, in the central cavity; the outgrowths above these central oral vessels have just the same structure as the lobes of the arms, into which they pass directly, and may therefore be regarded as "sucking knobs" or oral frills. Each of the eight arm-vessels divides into four longitudinal vessels, one of which is median; the three peripheral ones are connected by transverse anastomoses with the axial, and give off branches to the appended lobes.

The eight sensory organs agree in their external and general internal structure with those of the Hertwigs' second group of Acraspedota; the terminal network, in which the crystals lie, is regarded by the Hertwigs as being formed from the vessel which runs along the arm; Greef, however, thinks that this plexus is formed from the mesoderm, while the nerve-band breaks up into a fine nucleated plexus, which makes its way into the meshwork which

* Zool. Anzeig., iv. (1881) pp. 620–2.
† Ibid., pp. 568–70.

supports the crystals, and so comes into contact with them. In the upper wall of the terminal knob the author was able to detect an ocellus.

Sexual Cells of Hydroida.*—A. Weissmann finds that these are ectodermal in origin, but he allows that in some cases they are developed in the endoderm, and that in others the spermatozoa are ectodermal and the ova endodermal in origin; and he also recognizes the cœnosarcal origin of the elements in some cases. Together with this cœnosarcal origin, there may be development from cells situated in the sexual buds (*blastoid* origin), and *Hydrozoa* may therefore be spoken of as *cœnogenous* (abbreviated from cœnosarcogenous), or as *blastogenous;* and the author insists on the correctness of the view that in some cases the germ-cells are not developed until the medusa is completely formed.

The chief object of the present communication is to demonstrate that the sexual cells which arise in the cœnosarc are normal productions of great significance, and that in all such cases the cœnosarc and not the gonophores is to be looked upon as the true seat of the cells; and, further, to show that this mode of reproduction is very common, there being entire families in which the ova are so formed; while there are others in which the testicular products also are so developed. Of the latter, *Plumularia* (e.g. *P. echinulata*) is an example, for in it the cells are developed in the endoderm, principally of the trunk portion, but often also at the base of the lateral branches of the cœnosarc. The formation of the male and female gonangia is described in detail, and shown to be similar for both.

Gonothyrœa loveni is the first example of the Campanularidæ, and here the male elements are ectodermal, and arise, not in the cœnosarc, but in the gonophores, from an invaginated set of ectodermal cells. The ova, on the other hand, are formed from the endoderm of the cœnosarc and of the branches. In *Eudendrium ramosum* they are both formed from the endoderm, but the male elements are of blastoidal and the female of cœnosarcal origin. In *Cordylophora lacustris*, as Schulze was the first to show, the ova are cœnosarcal and ectodermal; the origin of the male elements has not been accurately worked out.

We find, then, certainly that in most (cf. next note) polyps with fixed gonophores the ovules do not arise in the gonophores but in the cœnosarc, and their appearance is the condition of the formation of a gonophore, into which they migrate. There is more variation in the male products, which do not appear to be so constantly cœnogenous; where, however, they are so, the development of the gonophore and the migration of the testes into them is essentially similar to that of the ovaries.

Spermatozoa of Hydrozoa.†—A. de Varenne has examined *Campanularia flexuosa*, *Gonothyrœa loveni*, and *Podocoryne carnea*, in which are found respectively a fixed gonophore, a demi-medusa, and

* Ann. Sci. Nat. (Zool.), xi. (1881) art. 6, 33 pp. (3 pls.).
† Comptes Rendus, xciii. (1881) pp. 1032–4.

a free medusa. In all cases the mother-cells do not appear in any part of the gonophore, but in the cœnosarc. Taking the first-named species, he found that before the appearance of any gonophore large highly-refractive cells appear in the endoderm of the cœnosarc; the presence of a certain number of these mother-cells determines the formation of a gonophore. Very soon the primary mother-cells multiply with great rapidity, and the daughter-cells, which are much smaller, form a horseshoe-shaped testicular mass, which, growing rapidly, ceases to form part of the endodermic wall, owing to the reconstitution of the unaltered endodermal cells, which now form a continuous layer below it. This explains the origin of the statement that the testicular cells are ectodermic in origin. There is, further, a great similarity between the development of the male and female elements. The author thinks that there is no true alternation of generations.

Porifera.

Attempt to Apply Shorthand to Sponges.*—The system here elaborated by Dr. G. C. J. Vosmaer is an extension of that first introduced by him in a paper on the *Desmacidinæ* of the Leyden Museum,† and its object is to give shortly the characters of a sponge by symbols which denote its several spicules. In the present scheme he tries to make his system of symbols so elastic as to admit almost any possible combination of characters in a spicule. Of course it is only applicable to sponges which have spicules, and does not take account of the *Carnosa* or the Horny Sponges; neither does it take account of the *proportions* (though the worker may readily add these himself); the author admits that it is not applicable to all cases, but claims for it the recommendation of saving some time and trouble in description. It is impossible to give here all the full formulæ used, so that in most cases only the abbreviations are given, which can be combined according to the requirements of different cases, and may help students of sponges to arrange for their own use, at any rate, methods of expressing shortly the often complicated spicular complements which may be met with. Dr. Vosmaer has used it for three years.

For *monaxial* (i. e. linear) spicules are used:—*tr* (truncate) = blunt-ended; *tr tr* = blunt at both ends, but not to same extent; *tr ac* (acute) = blunt at one end, pointed at the other (acuate, Bowerbank); *ac ac* = doubly-pointed, to different extents. Where the forms of the ends are similar, the formula is tr^2, ac^2, &c.; tr^0 *tr* = clavate or spinulate cylindrical, and tr^0 *ac* stands for the common spinulate or "pin-like" form; *f* = fusiform, *sp* = spined. Combinations of these signs supply formulæ for the thirty-two modifications of *straight* monaxial spicules. For *curved* forms of the same group the following abbreviations are used. An inverted V (Λ) for the tricurvate acerate, an S on its side (∽) for the bihamate; the same with two lines drawn across it, so as to make it resemble the sign for a dollar, stands for trenchant contort bihamate; *anc* is anchorate, anc^3 is tridentate

* Tijdsch. Niederl. Dierk. Vereen., v. (1881) pp. 197–206 (1 pl.).
† See this Journal, iii. (1880) p. 661.

anchorate, *anc*^{2} 3 being tridentate equi-, and *anc anc* 3 tridentate inequianchorate; *anc* 2 is bidentate anchorate. *Rut* (rutrum, a shovel) palmated anchorate.

For the *Hexactinellid*, or, as Vosmaer prefers to call them, *Triactinellid*, types (those with three distinct axes), the general denomination is *ha* (initials of ἕξ and ἄξων); the different radii are designated by R or r; thus when four of the six rays are small and two large, the formula for the spicule is $(4\,r + 2\,R)$; *sp* may be added for spined. Where the spicules are fixed, i.e. skeletal, a line is drawn over the formula; thus the skeleton spicule of *Farrea* becomes *ha* $\overline{(4\,R + 2r\,sp)}$; but the "fir-trees" of *Hyalonema*, &c., become *ha* $(4r + R\,f\,sp)$.

For *Tetractinellid* forms the general sign *ta* is used (τέσσαρες, ἄξων); in the common case in which one ray is longer or shorter than the rest, this odd ray is termed M (manubrium), and the others d (dentes); if these are bifurcate, *bif* is added to d. For the angles, that which M makes with the three d's—almost the only angle which varies—is termed ϕ; $>$ is *greater than*, $<$ is *less than*. A triradiate, being reckoned as a tetractinellid with one ray aborted, is expressed by *ta* $(M = 0)$. Thus porrecto-ternate of Bowerbank is *ta* $(\phi > 90°)$, patento-ternate is *ta* $(\phi = 90°)$, recurvo-ternate $(\phi < 90°)$; bifurcated-ternate is *ta. d. bif.* If necessary, such a formula as *ta* $(\phi > 90°)$ *d. bif* $(d' > d < M)$ could be used, where the three rays are bifurcate and of different sizes, but less than the odd ray.

Polyaxial forms, i.e. globates and stellates, may be termed *gl* (globulus) or *st* (stella), globo-stellates (with large ball for a centre) *gl. st.* For the spiral or double stellate (e.g. of some *Suberitidæ*), *st*^{2} is employed.

Protozoa.

Flagellata.*—J. Künstler states that in an incubating chamber *Cryptomonas ovata* germs found at different stages in development presented the following characters. The less advanced were formed by a nucleolus surrounded by a layer of protoplasm; soon one of their poles developed more rapidly than the other, and elongated. After it had reached a certain size it gave rise at its free extremity to an axial cord of protoplasm, which constitutes the first stage of the digestive tube. Here there appear some large vacuoles, which divide and rapidly multiply, and soon a cavity commences to be developed in the body, beginning as a lateral space, one on either side. In *Chilomonas paramœcium* there is, similarly, a vestibule to the digestive tube, an antero-lateral constriction, locomotor, striated, and other prehensile flagella, a stomach with granular walls, an intestine terminating in an anus, four tegumentary layers, and a nucleus with several nucleoli, whence is given off a tube which dilates into the incubating chamber in which the germs are developed. In *Chlamydomonas pulvisculus* there are four, and not two, striated flagella, which are inserted around an orifice leading into a small cavity, and giving off delicate tubes to the contractile vesicles.

A new species is *Astasia costata*, the ribbed form of which is due

* Comptes Rendus, xciii. (1881) pp. 746–8.

to the presence in their integument of regular rows of starch-grains. In this form the digestive apparatus consists of a narrow œsophagus, a large gastric pouch, the walls of which were not detected, and an intestine leading to an anus. A new generic form is represented by *Künckelia gyrans*, which is a fresh-water *Noctiluca*. The body is capable of elongation, and so is enabled to creep about. There is an enormous tentacle which exhibits very active movement when the animal is swimming. Under its cuticle there are two muscular layers, which are continued into the tentacle. The mouth appears to lead into a very large cavity. No phosphorescence has yet been observed in this form.

Infusoria Parasitic in Cephalopods.*—In an elaborate memoir, A. Foettinger enters more into detail into some of the characters of these forms.† In dealing with the suspected muscular fibrils, he says that in optical section they reveal themselves as bright spots, set at equal distances from one another, and placed near the cuticular envelope. They give rise to the appearance of a transverse striation, and these striæ, of which there are two systems, become both visible when the cover-glass is compressed on the animal. The differences in the position of the fibrils is due to a difference in their state of contraction; for as they contract their obliquity diminishes, and the part of the body which contains them becomes shorter and wider. In one case the author observed in *Benedenia* a nucleus extending throughout the whole length of the body. He regards the nucleus, the characters of which have been already detailed, as not forming a fixed element, but one gifted with the power of amœboid movements. *Opalinopsis sepiolæ* was on one occasion observed to conjugate and reproduce while in sea water, so that in this case we can see how the parasite may pass from one Cephalopod to another.

Parasites of the Echiurida.‡—Professor R. Greef describes *Conorhynchus gibbosus* nov. gen. et sp., a large Gregarine to which he previously gave the name of *Gregarina echiuri*. The creature, which lives in the digestive canal, is nearly always found, when adult, in conjugation. Each individual forms a hemispherical disk, and its surface is provided with a number of conical and warty projections. At the anterior end there is a considerable process which appears to serve as an organ of attachment; the form is completely transparent owing to the great development of vacuoles. There is a large nucleus. In size each adult is about 1 mm. long and 1 mm. broad. In the youngest stage observed, the Gregarine had the form of a *Monocystis agilis*, and the internal substance was opaque and darkly granular. *Distomum echiuri* n. sp., found in the seminal vesicles of *Echiurus pallasi*, is 2 mm. long, and is continued forwards anteriorly into a proboscidiform process. *Nemertoscolex parasiticus* n. gen. et sp., is a Nemertine of about 3 mm. long, found twice in the cœlom of *E. pallasi*, in the male as well as in the female.

* Arch. de Biol., ii. (1881) pp. 345–78 (4 pls.)

† See this Journal, i. (1881) p. 902.

‡ Nova Acta Acad. Cæs. Leop.-Carol. Germ. Nat. Cur., xli. ii. (1880) pp. 128–131, with figs.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Origin of the Embryo-sac and Functions of the Antipodal Cells.*—After referring to the views on these subjects already published by Warming, Vesque, Strasburger, Fischer, Ward, and Treub,† L. Guignard details a series of observations of his own on a variety of plants, to determine some of the controverted points.

As a type of the Mimoseæ, in which the phenomena are remarkably uniform, he takes *Acacia retinoides*. At the summit of the nucellus, beneath the epidermis, an axial cell, somewhat larger than the adjoining ones, divides into two superposed cells; one, the origin of the cap (*calotte*) in Dialypetalæ, in immediate contact with the epidermis; the other Warming's primordial mother-cell of the embryo-sac, situated at a greater depth; these he calls the apical and subapical cells. The apical cell gives birth to a tissue which is generally reduced to three broad cellular layers. The subapical cell rapidly enlarges, and becomes segmented horizontally in the basipetal direction, dividing thus into three superposed cells each equal in size to the mother-cell. Of these the lowest is alone the true mother-cell of the embryo-sac, enlarging at the expense of the others and of the lateral nucellar tissue. The nucleus increases in size, and becomes surrounded at first by granular protoplasm, then by grains of starch, which finally often entirely fill up the cell-cavity. Resorption soon commences in the two superposed cells; their nuclei lose their sharp outline, the cell-walls disappear, and the entire protoplasm has the appearance of a homogeneous and refractive mass, the nuclei becoming indistinguishable; finally the whole substance of these cells is absorbed in the development of the lower mother-cell.

This process is subject to certain variations; but it is always the lower cell which becomes the mother-cell, and absorbs the others. The starch-grains disappear during the formation of the eight nuclei which give rise to the synergidæ, the oosphere, the antipodal cells, and the two polar nuclei which coalesce in order to form the secondary nucleus of the embryo-sac.

In the Cæsalpinieæ the apical cell generally gives rise to a thick tissue which remains for a considerable time, even after impregnation. Variations occur in the subsequent development; and these are greater among the Papilionaceæ, not only in genera of the same tribe, but even in species of the same genus. In this order the apical cell gives rise only to two superposed cells; the subapical cell remains undivided, increases early, and displaces the others.

As a general result, whatever may be the differences in the origin and number of the cells which constitute the axial row of the nucellus, it is the inferior cell only which is the true mother-cell of the embryo-

* Bull. Soc. Bot. France, xxviii. (1881) pp. 197–201.

† See this Journal, ii. (1879) p. 903; iii. (1880) pp. 107, 979; i. (1881) pp. 260, 620.

sac; there is never any coalescence between two adjoining cells. In all the Leguminosæ the synergidæ and oosphere, the antipodal cells, and the secondary nucleus of the embryo-sac, are formed in the well-known mode. The antipodals often disappear after impregnation, in consequence of the resorption of the subjacent nucellar tissue. Their function, which is still very doubtful, seems to terminate shortly after their formation. In other orders of plants, on the contrary, they increase considerably, even after impregnation. As in the majority of Angiosperms, there are no anticlinals, the mother-cell of the embryo-sac being the last of the row.

The presence of two nuclei in one or more cells, as in *Cercis*, does not furnish any real analogy with the special mother-cells of pollen-grains, because their division-walls are never completely resorbed.

Antipodals with several nuclei occur in some Ranunculaceæ, as *Clematis* and *Hepatica triloba*. The cells are always three in number, and are inserted at the base of the embryo-sac, to which they are attached by a kind of pedicel. Each of them has a nucleus containing at first a single nucleolus. Long before impregnation two nucleoli appear (in the hepatica) isolated in the substance of the nucleus; there is an internal line of separation between them corresponding to a slight depression on the surface, which gradually deepens, and finally divides the mother-nucleus into two parts, in which the same phenomenon may then be repeated, though this is not usually the case. The whole then presents the form of four segments, in which the nucleoli multiply; and the protoplasm itself may be divided into five, six, or even eight rounded fragments. The nucleoli do not elongate into an hour-glass form, nor does the substance of the nucleus present any median constriction, as is generally the case in fragmentation; they are rather granulations of the nuclear protoplasm, which soon attain a considerable size. Finally the mother-nucleus is filled with granular nucleoli, and becomes enveloped in the protoplasm.

There appears, therefore, to be a special process of fragmentation in organs whose function is completed, and which may be regarded either as an organic residuum or as a degraded prothallium.

Polyembryony in Mimoseæ.*—According to L. Guignard, polyembryony is a not uncommon phenomenon in the Mimoseæ, especially in *Schranckia uncinata* and *Mimosa Denhartii*, and is allied, in the former case, with other abnormalities of structure.

In *S. uncinata* the tigellum is furnished, towards its extremity, with an appendage of variable form, lobed, and descending below the cap which clothes the embryonal radicle. The internal structure of this appendage presents several interesting peculiarities. In addition, several embryos, formed of an internal normal structural axis, and furnished, or not, with this appendage, present three or even four foliaceous cotyledons of equal length folded longitudinally in various ways. When the number of cotyledons is three, they occupy the angles of an equilateral triangle, and one of them is inserted at a

* Bull. Soc. Bot. France, xxviii. (1881) pp. 177–9.

different level from the others; when the number is four, they are arranged in two opposite pairs at different levels. Instead of a single tigellum, there are often two of equal size, united in growth during the greater part of their length, but distinct towards the base. One of these axes occupies the normal position, the other being applied to it laterally.

The appendage is undoubtedly a reserve of food-material. When a seed possessing it germinates, it is exposed along with the radicular extremity, increases for some time after the rupture of the testa, then gradually loses its starch, which it gives up to the embryo, and finally dries up and perishes.

Resistance of Seeds to extreme Cold.* — E. Wartmann has exposed fresh-gathered Spanish chestnuts for nearly two hours to a cold of at least $-110°$, derived from a mixture of sulphuric ether and solid carbonic acid, each seed being carefully wrapped in thin tinfoil, so as to prevent the surface coming into contact with the ether. The chestnuts were then planted in the soil; they germinated and developed in every respect as successfully as those which had not been exposed to the cold. The power of resistance to extreme cold appears, indeed, to be a very general property of seeds.

Mechanical Contrivances for the Dispersion of Seeds and Fruits.†—A. Zimmermann has subjected to a fresh examination the structure of the seed-vessels of Gramineæ, Papilionaceæ, and Geraniaceæ, by the torsion of which the seeds are buried in the soil, especially in relation to the alternate turgidity and desiccation of the tissues. His conclusions, which are mainly in accord with those of C. and F. Darwin, are as follows:—

1. The hygroscopic torsion of the awns of Gramineæ is the result of the effort after torsion of the outer cells of the stereome, and of the strong contraction of its inner cells, which probably assist by the fact that when they swell they assume an oblique position. The micella of the former cells are arranged in spiral lines, those of the latter in oblique rings.

2. The effort after torsion of a single spirally striated cell is caused by unequal intensity of swelling and unequal firmness in the direction of the two systems of rows of micella. The swelling of an imaginary cylinder without thickness causes, in general a torsion in the direction in which there is the strongest swelling. The radial swelling of a cylinder possessing thickness, causes, when it is strongest, a torsion in its outermost layers in the direction of less firmness; in the inner layers, one in an opposite direction. The most probable explanation of the fact that a cell in which the most strongly marked striations and pores are arranged in spirals inclined obliquely to the left, turns itself to the right when it swells, to the left when it dries up, is that on the one hand the swelling is strongest in a direction vertical to these striations and to that of the pores; on the other

* Arch. Sci. Phys. et Nat., v. (1881) p. 343. See Naturforscher, xiv. (1881) p. 276.

† Pringsheim's Jahrb. wiss. Bot., xii. (1881) pp. 542–77 (3 pls.).

hand, the firmness is greatest in the direction of the rows of micella and of the pores.

3. The cause of the torsion of the legumes of *Orobus* and *Caragana* resides in the layer of resin, and is brought about in it by unequal contraction in the transverse direction, which is indicated by anatomical differences. The outer epidermis (and its anatomical strengthening in *Caragana*) acts only by increasing the strength of the mechanism, the vascular bundles of the margin detracting from its efficiency.

4. The torsion of the awns of *Geranium* is caused by unequal contraction of the cells in the longitudinal direction, these cells manifesting also differences in the form and direction of their pores. In the awns of *Pelargonium* the outer strongly developed epidermis effects the torsion by strong curvature, the direction of the torsion being rendered spiral by the tendency to torsion of the inner cells.

5. The violent expulsion of the seeds of *Oxalis* is not caused by turgidity, but by the energetic swelling of the cell-walls of the transparent outer layer.

Chemical Difference between dead and living Protoplasm.—The view maintained by O. Loew and T. Bokorny,* that living cells are chemically different from dead ones, in that living protoplasm shows an aldehyde nature by its power of reducing extremely dilute alkaline silver solutions, while dead protoplasm does not, has been the subject of an interesting discussion at the Berlin Chemical Society, when Herr Reinke denied the chemical difference, and insisted that at least a part of the reaction is due to a volatile substance of aldehyde nature which is very frequent in green cells, and which he is disposed to regard as formic aldehyde, the first product of assimilation of carbonic acid in the plant.

His opponents urged that they had carefully examined the distillation products of various species of Algæ and of germs without chlorophyll, but had quite failed to find any silver-reducing substance. Thinking, further, that they might have been misled by the action of sugar or tannin, they convinced themselves that cells reduce which have neither of these substances, and a living cell will easily reduce a very dilute silver solution which sugar and tannin fail to reduce. The intimate relation between silver-reducing power and life (in their opinion) is shown clearly by the fact that in whichever of many different ways cells of Algæ were killed, the reaction in question ceased with their death, and precisely at the degree of temperature at which life is extinguished. This is generally the case in killing by poison; strychnine alone being an exception, which is explained by the existence of a combination of the alkaloid with molecules of the active albumen.

Energy of Growth of the Apical Cell and of the youngest Segments.†—M. Westermaier commences a dissertation on this subject with an historical sketch. Naegeli and Schleiden attributed the causes

* See this Journal, i. (1881) p. 906.

† Pringsheim's Jahrb. wiss. Bot., xii. (1881) pp. 439–72 (1 pl.).

of the form of any particular part of a plant to the individual cells, so that the individual cell plays a prominent part, and the behaviour of these determines the form of the organ. A different view is held by Hofmeister, Sachs, De Bary, and Hanstein, who regard as the primary fact the form of the organ itself, which then determines the form and mode of division of the cells. An intermediate position between the two is held by Schwendener; the arrangement of the cells and the directions of the dividing walls being, according to him, determined by two variable factors:—(1) by the individuality of the cell; (2) by the form or complete growth of the entire organ, to which Schwendener also attributes a share in the arrangement and growth of cells. The final position of the walls and arrangement of the cells is often also influenced by pressure.

In order to determine the relative energies of growth of the cells of the apical region, the author proposes the following theoretical considerations:—

1. "The apical cell displays the same activity with regard to increase in volume during successive stages." By a stage the author means the time which elapses between the formation of a division-wall in the apical cell and the formation of the next following division-wall.

2. "The successive segments display an equal activity with regard to increase in volume during successive stages." In this connection the relationship is investigated between the volume and the projection of the lateral profile of a triangular pyramidal and of a two-edged apical cell.

After these theoretical propositions, a comparison is made of the energy of growth of the apical cell in *Dictyota* (according to Naegeli), *Hypoglossum Leprieurii* (Naegeli), *Metzgeria furcata* (Goebel), *Salvinia natans* (Pringsheim), *Equisetum arvense* (Cramer), *E. scirpoides* (Reess), and *Selaginella Martensii* (Pfeffer).

The general result is stated as follows: — The maximum of increase in volume lies in general either in the apical cell itself or in the youngest segments. If we look only at the region which includes the apical cell and the four youngest segments, in none of the cases mentioned above is the increase of volume least in the apical cell.

Action of Nitrous Oxide on Vegetable Cells.*—Prof. W. Detmer has tried a series of experiments on the influence on vegetable tissues of nitrous oxide gas, which he states may, to a certain extent, replace oxygen in the respiration of plants. For this purpose he took pains to obtain the gas absolutely pure, and carefully to exclude every trace of atmospheric air. The main results of his experiments, made on *Triticum vulgare* and *Pisum sativum*, are as follows:—

1. When grains of wheat or peas are made to swell in water which has been boiled and allowed to cool, and then placed for a considerable time in contact with pure nitrous oxide, they lose their power of germination.

* SB. Jenaisch. Ges. Med. u. Naturwiss., 1881, July 1. See Bot. Ztg., xxxix. (1881) p. 677.

2. If their contact with the gas is not so long, say from one to three days, they do not entirely lose the power of germinating; the embryo will begin to develope under normal conditions.

3. A longer contact with the gas kills the cells.

4. In a mixture of two parts by measure of nitrous oxide and one part of atmospheric air, the power of germination of peas is very greatly weakened.

5. If peas have been made to germinate under ordinary conditions, and then brought into pure nitrous oxide, no further development whatever of the root and stem takes place.

6. In pure nitrous oxide no geotropic or heliotropic curvatures take place.

7. Etiolated parts of plants do not become green in the light if surrounded by an atmosphere of pure nitrous oxide.

8. A number of experiments prove that vitally active cells are not able to decompose nitrous oxide; and that they therefore have no power of using its oxygen for the purpose of respiration.

Chlorophyll and the Cell-Nucleus.*—G. Schaarschmidt makes the following observations:—

1. Division of chlorophyll. The mode of division of the chlorophyll-grains resembles that of the nucleus, and takes place either directly by constriction, or indirectly by division with formation of threads. All green chlorophyll-grains divide in one or other of these ways, as does also the endochrome of diatoms, as, for example, the coccochrome of *Odontidium vulgare*, and the placochrome of *Himantidium pectinale*.

2. Hypochlorin occurs also in the Cryptophyceæ and diatoms. When *Nostoc*, *Microcoleus*, *Merismopedium*, and *Oscillaria*, had been treated for two days with concentrated, and then for four days with dilute hydrochloric acid, and preserved in it, three, four, or more minute rusty-brown masses made their appearance on the surface of the cells, which showed the characteristic properties of hypochlorin. The endochrome of diatoms treated in the same way becomes dirty green, and assumes a spongy structure, hypochlorin appearing at the margins in the form of irregular brown masses. This occurred in *Cymatopleura Solla*, *Himantidium pectinale*, *Synedra splendens*, *Pinnularia viridis*, *P. radiosa*, &c., and especially in *Synedra ulnæ*. The reactions were not, however, successful in every individual.

3. The cell-nucleus of *Nostoc*. A small round body was observed in the cells of *Nostoc*, usually in contact with the division-walls, and which showed beautiful phases in the division of the cells. When the cell has elongated and is ready for division, this body parts in the middle, a colourless central zone being thus formed in the midst of the colouring substance. When oblong cells are placed in coloured alcohol-material, the nucleus is constricted; the constriction becomes gradually deeper, and a furrow appears on the outside of the cell.

* Schaarschmidt, G., 'Morphology of Chlorophyll and of the Vegetable Cell-nucleus' (in Magyar); with drawings and a photogram. 56 pp. Klausenburg, 1881. See Bot. Centralbl., vii. (1881) p. 263.

Finally the daughter-nuclei divide, and are kept together only by a narrow bridge; when the cell-division is complete, these nuclei are found again on the division-walls. The diameter of these minute bodies is only from 0·5 to 0·6 μ; their behaviour when dividing and towards colouring reagents is opposed to the view that they are chromatin or microsomes.

Influence of Warmth of the Soil on the Cell-formation of Plants.*—E. Prillieux finds that the effect of warmth in the earth is to cause a hypertrophy of the interior of the stem in a young plant; when closely examined, this is found to be accompanied by multiplication of the cell-nuclei. In the bean and the pumpkin, when the seeds have germinated in earth of 10° higher temperature than the surrounding air, cells are often found containing two or three massed or isolated nuclei, which may be either equal or unequal in size, and of various shapes. This multiplication is effected by fission of the nuclei, which generally contain several nucleoli, up to the number of four or five, of very different forms and sizes, and sometimes obviously constricted preparatory to their division. At the time of division, a boundary wall placed either opposite a large nucleus or between two closely apposed small ones, divides the nucleus into two halves; these two halves swell up, and the whole has usually a kidney-like shape. The process is completed by prolongation of the grooves of the surface through the dividing wall.

Growth of Starch-grains by Intussusception.†—In replying to the attack by Schimper‡ on the theory of the growth of starch-grains by intussusception, C. Naegeli points out that there are three different conditions of the "micellar" constitution of the cell-wall (using the term "micella" to distinguish the physical ultimate elements of a substance from the chemical molecules or atoms) viz.:—(1) The living condition of the cell-wall, when it is in immediate contact with living cell-contents; in this condition the cell-wall is more or less strongly coloured by aniline pigments, while the contents do not take up any of them. (2) The cell-wall is in a naturally dead state when the living contents separate from it, or when they die while still remaining in contact with it; in this condition the cell-wall does not take up any pigment, while the contents become coloured; and if the cell-wall was coloured when living, it loses its colour on passing into the dead state. (3) The swollen condition is caused by the action of alkalies or acids, by long boiling in water, or by lying for a sufficient time in cold water; in this state the cell-wall is again capable of being coloured.

In every stage of its growth the starch-grain is a material system surrounded by a watery fluid, and saturated with water, the tensions of which are in a condition of equilibrium. When the grain becomes dry, crevices are formed, a proof that the equilibrium is by this means

* Kosmos, viii. (1881) pp. 63–4.

† Bot. Ztg., xxxix. (1881) pp. 633–51, 657–77; also SB. Akad. Wiss. München, xi. (1881) pp. 391–438.

‡ See this Journal, i. (1881) p. 909.

destroyed; and the fissures have a radial direction crossing the layers at right angles, a proof that more water is lost in the tangential than in the radial direction, and that the total quantity of water deposited in the tangential direction is greater. When substances which cause artificial swelling act slowly on the naturally saturated starch-grain, it increases in volume, radial fissures being again formed, a proof that during this process more water is deposited in the radial than in the tangential direction. He argues, on mechanical grounds, that the tensions found in starch-grains can be accounted for only by intussusception, and that these tensions can cause the secretion of the soft nucleus and the soft layers only on the supposition that intussusception is at the same time taking place.

Collenchyma.*—H. Ambronn has carefully investigated the history of development and the mechanical properties of collenchyma in a number of instances, especially in *Colocasia esculenta* and other allied aroids, and in Umbelliferæ and Piperaceæ.

With regard to the history of its development, these observations confirm the statement of Haberlandt that, as in the case of bast, no uniform origin can be ascribed to the collenchyma, but that it varies in every possible way. Also that the grouping and arrangement of the cells is the result, in the first place, of purely mechanical and not of morphological laws; and that, when definite relationships exist between the collenchyma and the mestome (in Schwendener's sense of the term), these relationships are explained by the history of development. These relationships occur in those plants in which the origin of the collenchyma and of the mestome is uniform, and in those in which projecting ridges or angles are produced by the formation of vascular bundles at the periphery, groups of collenchymatous cells being developed in them in consequence of their centrifugal tendency.

As regards the structure of the collenchymatous cells, they have in general a prosenchymatous character. They are moderately long, often 2 mm. or more, and very frequently manifest subsequent segmentation by delicate division-walls. They are always filled with sap, but contain little or no chlorophyll. The longitudinal walls of the cells have usually longitudinal crevice-like pores.

Other collenchymatous cells, on the contrary, have more of a parenchymatous character, and have usually been formed by secondary collenchymatous thickening of parenchymatous cells.

The cell-walls of collenchyma are always coloured a bright blue by chlor-iodide of zinc, but are not coloured by the action of phloroglucin and hydrochloric acid. Their power of swelling in water is not so strong as has usually been supposed; the cells are seldom contracted by more than ½ per cent. of their entire length by the application of desiccating reagents.

The elements of the formative tissue out of which the collenchymatous cells are subsequently developed are partly cambial, partly belonging to other meristematic portions. But very often there is no special formative tissue; the collenchymatous thickening taking

* Pringsheim's Jahrb. wiss. Bot., xii. (1881) pp. 473–541 (6 pls.).

place only as a secondary result in parenchymatous cortical cells. But we have not yet sufficient knowledge to divide collenchymatous tissue on this ground into subsections.

Collenchymatous cells differ in one very essential point from true bast-cells. While in the latter the limit of elasticity nearly coincides with absolute firmness, in collenchyma the elasticity is overcome by a comparatively small strain, the firmness only when the strain is increased three or fourfold.

Since, therefore, a permanent elongation results from the tension to which the collenchyma is subjected in the young turgid internodes and leaf-stalks, but no rupture, it is clear that this tissue can, in consequence of its great absolute firmness, afford the necessary assistance to the intercalary construction of these organs, without however interfering with their growth in length. That the growth in length of the collenchyma itself is a consequence of this tension caused by the turgidity of the other parts of the tissue, can scarcely be doubted. But whether the permanent elongation of the collenchymatous parts, caused by the passing of the limit of elasticity, plays any definite part in this process, must remain undecided in the present imperfect state of our knowledge of the processes of growth in the cell-walls.

Epidermis of the Pitchers of Sarracenia and Darlingtonia.*— Prof. A. Batalin has made a careful anatomical examination of the pitchers of *Sarracenia flava*, *purpurea*, and *variolaris*, and *Darlingtonia californica*. He finds that the lower region of the inner epidermis, the "detentive surface" of Hooker, has no cuticle; while all the other cells of the detentive surface have one, and especially the long stiff hairs. The inner region of the pitcher is of a uniform bright-green colour within and without; but this is true of the inner surface only so long as no insects have been captured; it then becomes brown, the green colour of the outside remaining. While on the green spots on the inside of the pitcher the moderately thick and nearly colourless outer walls of the epidermal cells are quite smooth, at the brown spots, where insects have come into contact with them, they have one or more irregular spots of a much lighter colour. Treatment with chlor-iodide of zinc causes these spots, but not the rest of the cell-walls, to turn blue.

This observation leads to the conclusion that the contact of an insect with the epidermal cells causes a change in the latter, which consists chiefly in the excretion, between the cuticle and the cellulose-wall, of a fluid, the nature of which has not been determined, but which probably has the property of dissolving albuminoids. It appears to act both mechanically and chemically upon the cuticle, forcing it outwards, and finally rupturing and almost entirely destroying it. A change is at the same time taking place in the cellulose-wall. It assumes a brown colour, and in addition becomes partially mucilaginous.

The author also describes a peculiar sieve-like disk between the epidermis and the glands of *Pinguicula vulgaris*.

* Acta Hort. Petrop., vii. (1880) pp. 343–60 (1 pl.). See Bot. Centralbl., vii. (1881) p. 327.

Laticiferous Vessels.*—D. H. Scott has investigated the structure and development of the laticiferous vessels, chiefly in *Tragopogon eriospermus;* also in *Scorzonera hispanica*, *Taraxacum officinale*, and *Chelidonium majus*. The following are the most important results:—

The laticiferous vessels are developed out of rows of cells, the transverse walls of which have been gradually absorbed, and, when two vessels lie side by side, the lateral walls also partially. The resorption usually takes place at an early period; in seedlings during the first stages of germination; in the secondary cortex shortly after the cells in question have separated from the cambium.

The connection between distant laticiferous vessels is brought about in two ways; either by rows of cells that run transversely coalescing with one another, or by protuberances which unite in their growth, and which finally form canals similar to those of the Conjugatæ.

Even before the first septa are absorbed, the cells are characterized by special contents, of which latex is probably a constituent.

Epidermal System of Roots.†—L. Olivier has made a careful study of the epidermal tissue in the roots of Vascular Cryptogams, Gymnosperms, Monocotyledons, and Dicotyledons, dividing the latter into two classes, those in which the secondary vascular system originates early, and those in which it originates late. The following are the general results:—

The piliferous layer of the root does not correspond to the epidermis of the stem, but rather to one of its hypodermal layers. It is this which gives birth to the "veil," a system of layers of cells proceeding from the piliferous layer; as it peels off, the subjacent or epidermoidal layer most generally assumes the anatomical character of the epidermis, and the same physiological functions.

The secondary tissue of the epidermal system of the root is either parenchymatous or of a corky nature. The secondary epidermal parenchyma proceeds from a peripheral layer of the central cylinder; it attains considerable development in Dicotyledons with early secondary vessels, and in Gymnosperms; there is none in Vascular Cryptogams, in the great part of Monocotyledons, nor in Dicotyledons with late secondary vessels.

In Gymnosperms and in Dicotyledons with deciduous primary bark, the cork is derived from the pericambial layer. It is composed of tabular cells, the radial walls of which are very short.

In woody Dicotyledons with late secondary vessels, in Monocotyledons, and in Vascular Cryptogams, the production of cork takes place in the external zone of the cortical parenchyma; the cork is here composed of cubical cells.

In any particular species, the zone of the root where the cork appears depends on the transverse diameter of the organ, and on its physical surroundings. The diameter being the same, the cork is generally earlier and more abundant in the aerial than in the underground roots.

* Scott, D. H., 'Zur Entwickelungsgeschichte der gegliederten Milchröhren der Pflanzen.' Inaugural Dissertation. 23 pp. Würzburg, 1881.

† Ann. Sci. Nat. Bot., xi. (1881) pp. 5–129 (8 pls.).

Passage from the Root to the Stem.*—R. Gérard concludes from a careful examination of the facts connected with this subject that a "collar" does not exist as a geometrical expression. Between the root and the stem is a region, more or less extensive, where the elements of the root, advancing to the higher parts of the axis, become modified, gradually assuming the configuration, place, and importance which they possess in the stem. The transformation of each of the elements is independent of that of its neighbours, and may take place slowly or very rapidly. Hence the collar, considered anatomically from different points of view, presents the most variable aspects. The transformation of the epidermal system furnishes no guide to the limitation of stem and root; the change in the epidermis is one of the phases of the passage.

Using the term in its widest sense, the collar may commence in the upper part of the radicle and extend to the fourth internode, rarely passing the cotyledons, or it may be entirely localized in the radicle; it may occupy a part of the organ, and the whole or a part of the tigellum. Most often the passage is completely effected in the tigellum. The size of the collar is in proportion to the diameter of the plant.

No family characters can be drawn from the study of the collar; its peculiarities are constant only in the species. It is connected with the accommodation of the plant to its surrounding conditions.

Causes of Eccentric Growth.†—Dr. E. Detlefsen has investigated the cause of eccentric growth in thickness of woody stems and roots in a number of instances, and finds it attributable to the four following causes:—

1. Branches and axillary roots cause, at the point from which they spring, a diminution of the tension of the bark, and consequently an acceleration of the growth in thickness, which is most considerable where the surface of the lateral organ forms the smallest angle with that of the mother-organ.

2. Every diminution or increase in the tension of the bark is perceptible over a large extent in the longitudinal direction of the bast-fibres.

3. Every lateral pressure which causes curvature of the organs brings about an increase in the tension of the bark on the side which becomes convex, a diminution on that which becomes concave.

4. Convex surfaces cause an increase, concave surfaces a decrease, in the tension of the bark, which affects chiefly the different sides of curved branches and roots.

These influences may be exercised either in conjunction or separately.

Hydrotropism of Roots.‡—The term "hydrotropism" has been suggested for the tendency displayed by roots, when placed between a

* Ann. Sci. Nat. (Bot.,) xi. (1881) pp. 277–430.

† Detlefsen, E., 'Versuch einer mechanischen Erklärung des excentrischen Dickenwachsthums verholzter Achsen u. Wurzeln.' 13 pp. (1 pl.) Weimar, 1881.

‡ Bull. Soc. Bot. France, xxviii. (1881) pp. 115–21.

moist and a drier medium, to direct themselves towards the former, to an extent often sufficient to overbalance geotropism. As the result of a series of observations, M. Mer contests the view that hydrotropism is a special instinctive faculty of the root; he attributes the phenomenon to the retardation of growth consequent on an insufficient supply of moisture, a condition which may completely prevent the manifestation of geotropism.

Cause of the Swelling of Root-fibres.*—E. Mer and M. Cornu have observed that when the roots of growing plants are placed in coloured fluids, if the solution is too concentrated so as to check growth, each root-fibre swells near the apex, the swelling being often accompanied by a more or less decided curvature. M. Cornu attributes this phenomenon to the same cause as the swellings caused by phylloxera and by gall-insects, viz. not the special influence of a particular fluid, but tensions developed locally by any cause, and in many cases the arrest of development of an organ in course of elongation; the production of a fluid may, however, in certain cases co-operate with this.

Frank's Diseases of Plants.—The completion of this work, to the publication of the 1st part of which we have already alluded,† furnishes a very complete account of the various diseases and injuries to which plants are subject. It is divided into five sections, as follows:—1. The living and dead state of the vegetable cell. 2. Action of mechanical influences. 3. Diseases caused by influences of inorganic nature. 4. Diseases caused by other plants. 5. Diseases caused by animals.

Under the first head the author describes the phenomenon known as the "apostrophe" of the chlorophyll-grains. The normal position of the chlorophyll-grains he states to be in a layer especially next to those parts of the cell-wall which are not in contact with adjacent cells—on the outer side, therefore, of epidermal cells, and on walls that border intercellular spaces; and to this position he applies the term *epistrophe*. Certain unfavourable influences, as long-continued absence of light, wounds, &c., cause the chlorophyll-grains to lose this position, and group themselves along those cell-walls that are in contact with other cells; and this abnormal position he calls *apostrophe*.

The production of wens is thus described. The first cause is always a small wound in the periderm, which sometimes appears to be a crevice over a lenticel. Between the dried margins of the outer ruptured cortical layer there then projects a living new formation in the form of a light-brown cushion, which is either a round tuber or a long wheal, according to the shape of the wound; a cluster of smaller tubers often break out in addition from the bottom of the wound. When this cushion projects to a height of 1 mm. above the wound, it consists only of cortex and bast, not of wood; it is a hypertrophe of the cortex, enclosed in a young periderm. The parenchymatous

* Bull. Soc. Bot. France, xxviii. (1881) pp. 124–7.
† See this Journal, i. (1881) p. 273.

tissues of the cortex and bast form the greater part of this cushion. At its base and in the neighbourhood of the bast of the stem is a hard, horny tissue, consisting of extremely thick-walled cells, resembling the bast-fibres, but short, also nearly iso-diametric, also of sclerenchymatous cells of great size, their cell-walls so greatly thickened that the cavity has nearly disappeared, and with pit-canals. At a later stage the woody tissue is also enclosed in the hypertrophy. Nothing is said by the author about adventitious buds.

Among parasitic fungi causing diseases of plants, Frank includes species of Chytridiaceæ, Saprolegniaceæ, Peronosporeæ, Ustilagineæ, Uredineæ, Hymenomycetes, Discomycetes, and Pyrenomycetes; and describes the following new species, viz.:—*Saprolegnia Schachtii*, on *Pellia epiphylla; Ramularia Viciæ*, on *Vicia tenuifolia; Cercospora Phyteumatis*, on *Phyteuma spicatum;* and *Glœosporium Phegopteridis*, on *Phegopteris polypodioides.* The mycelium of *Agaricus melleus* he regards as the cause of the extensive vine-disease known in France as "blanc des racines." The sclerotial disease of rape-seed is caused by *Peziza sclerotioides;* and that of *Impatiens glandulifera* and other species of Balsamineæ by a fungus to which Frank gives the provisional name *Sclerotium Balsaminæ.* The lowest internodes of the stem lose their turgidity, become flaccid, and look as if they had been boiled; and the plant quickly dies. The tissue is penetrated by a mycelium on which are small black sclerotia.

A full account is given of the production of galls by *Phytoptus* and other gall-producing insects. The following description is given of the formation of the bag-shaped galls on the leaves of *Prunus Padus.* The insect probably in the first instance inflicts injuries which excite the production of the galls; but they only retreat into the galls at a later period when the care for their offspring comes into play. The same appears to be the case with *Erineum tiliaceum.* The insect could not be detected either at the spot where the injury is first made, or in the immature gall; not till the beginning of June, when they are found in abundance, with their eggs, in the galls. In the case of the lime the injury appears to act on both sides of the leaf.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Prothallium and Embryo of Azolla.*—Prof. S. Berggren has followed out carefully the development of the prothallium and embryo of *Azolla caroliniana.*

As in *Salvinia* the endospore splits, on germination, along its three edges. On escaping, the prothallium has the form of a slightly convex disk, consisting in the middle of several layers of cells, at the margin of only one, and separated below by a thin hyaline membrane from the large protoplasmic spore-cavity. Shortly afterwards an archegonium is formed near its centre, consisting of four cells enclosing the oosphere and of four neck-cells. If this archegonium is fertilized, no

* Lunds Univ. Arsskrift., xvi.; and Rev. Sci. Nat., i. (1881) pp. 21–31 (1 pl.).

others are usually formed, but if not a few others are subsequently developed. When quite mature the part of the prothallium which projects outside the spore is nearly hemispherical, and three obscure wings are produced by three longitudinal furrows. The cells contain chlorophyll.

The position of the oosphere with respect to the neck of the archegonium probably corresponds to that in *Salvinia*. After fertilization it is divided by the first oblique division-wall into a smaller upper cell facing the neck of the archegonium, and a somewhat larger lower cell filled with coarsely granular protoplasm. By successive walls vertical to one another and to the first division-wall, and parallel to its longitudinal axis, the embryo is then divided into octants. In each octant a wall next appears parallel to the first division-wall; and the entire embryo then consists of 16 cells, arranged in four parallel rows.

The four cells which lie at the upper pole are the rudiment of the foot. Of the four lowermost cells one is the origin of the apex of the stem, another developes into an organ resembling the first leaves, the two others are together the rudiment of the scutellum. In its subsequent growth the young apex of the stem follows the ordinary laws; only the bud is at first straight, and the characteristic curving upward of the cone of growth is a subsequent phenomenon. The leaves first produced are strongly concave, and, in contrast to the later ones, are not lobed. Some of the hairs which mark the upper side of the apex of the stem are formed at the same time as the first leaf. The scutellum originally encloses the bud as a crescent-shaped growth, the margins of which gradually approach until it encloses it like a sheath. The leaf-like organ resulting from the second cell of the lower pole of the embryo is at first, like the scutellum, independent of the apex of the stem, and morphologically equivalent to it. Neither can therefore accurately be termed a leaf. The first vascular bundle of the plant is formed at an early period by tangential walls in the eight cells which compose the centre of the embryo.

After fertilization the embryo turns, as in *Salvinia*, within the archegonium, so that the apex of the stem is turned towards that of the prothallium. The embryo breaks through the prothallium near the archegonium, and the prothallium then surrounds the foot of the embryo like a cup, carrying the withered archegonium on its dorsal side behind the scutellum.

To prepare for fertilization, the massulæ of the microsporangia, with their anchor-shaped glochidia, fix themselves in large numbers to the under epispore of the macrospores which are floating on the surface of the water. The central fibrous portion of the floating apparatus is perforated by a narrow canal, through which the antherozoids probably reach the archegonium. By their subsequent growth the prothallium, and later also the embryo, force themselves into this canal, and increase its size. By this means the three floating bodies are displaced from their original position, and finally stand at a right-angle from the macrospore. The indusium which covers the floating apparatus in the form of a brown cup is at the same time pushed

upwards, and finally forced against the embryo. The hood-like fibrous layer which is closely applied to the floating apparatus, is turned over, and surrounds the foot of the embryo like a collar. Shortly afterwards the embryo detaches itself from the macrospore; the margins of the scutellum become broader, and then lie on the surface of the water in the form of cups or scales.

The strongly refractive bodies previously observed by others between the indusium and epispore, are, according to the author, *Nostoc*-cells, which find their way into the crevices between the scutellum and the young leaves when the apex of the embryo appears outside the epispore.

Development of the Sporangia and Spores of Isoetes.*—On the disputed point whether the sporangia of *Isoetes* spring from superficial or from deeper lying cells, E. Mer considers that he has demonstrated the latter from the case of sterile leaves which are the result of the abortion of the sporangia at various stages.

In the earliest stage of development of the sporangium, while the leaves are still in vernation, it is not connected with the leaf by a pedicel; the tissue is, on the contrary, homogeneous, composed of young, very delicate, polyhedral cells, with no trace of trabeculæ or envelope. The pedicel is afterwards formed by expansion of the lateral parts. The cells of which it is composed differ from those of the rest of the organ; they are elongated horizontally, are polyhedral, with very acute angles, and enclose starch. The macrosporangia and microsporangia can be distinguished even at this period. Among the cells of the macrosporangium appear radiating rows of cells, similar to those of the pedicel, which are the young trabeculæ; the external envelope becoming at the same time differentiated.

In the second stage the mother-cells of the macrospores increase in size, and contain vacuoles, growing at the expense of other cells which decrease in size and at length entirely disappear. The nutritive tissue is finally confined to one or two rows of cells situated at each side of the trabeculæ, which no longer contain starch.

In the third and final stage the mother-cells of the macrospores divide into tetrahedra; the macrospores become isolated, and float in the empty space between the trabeculæ. The mother-cells of the microspores cannot be made out till a later period than is the case with the macrospores.

In the primitive meristem, from which are developed the macro- and microsporangia, three tissues are speedily differentiated: viz. a formative tissue destined to produce the mother-cells; a nutritive nitrogenous tissue, which is absorbed at the expense of the mother-cells; and an amylaceous nutritive tissue intended to supply the mother-cells with nutriment.

M. Mer found that the supply of food-material caused a remarkable difference in the development of *Isoetes lacustris*, of which he accordingly distinguishes four forms. An abundant supply of food is necessary for the formation of the macrosporangia, an

* Bull. Soc. Bot. France, xxxviii. (1881) pp. 72-6, 109-13.

insufficient supply promoting the production of microsporangia. The dissemination of the macrospores extends over a longer period than that of the microspores. The bulbils correspond in this respect to the macrospores.

Muscineæ.

New Genera of Mosses.*—C. Müller describes four new genera of mosses:—*Wilsoniella*, belonging to Bryaceæ, one species from Ceylon, and another from Australia; *Thiemia*, belonging to Funariaceæ, one species from Burmah; *Rehmanniella*, belonging to Pottiaceæ, one species from South Africa; and *Hampeella*, belonging to Hookeriaceæ, one species from Java.

Classification of Sphagnaceæ.†—C. G. Limpricht lays considerable stress, in the determination of species of *Sphagnum*, on the relative position of the chlorophyllaceous and the hyaline cells in the leaves of the branches, a character which he considers has been too much neglected by Warnstoff in his recent synopsis of the group.‡ Limpricht reunites *S. subbicolor* Hampe and *S. glaucum* v. Klinggr. to *S. cymbifolium*.

Characeæ.

Cell-nucleus in Chara fœtida.§—F. Johow has made an extensive series of observations on the changes which take place in the nucleus in cell-division in *Chara fœtida*, for the purpose of determining the correctness on the one hand of Schmitz's description of it as "direct division of the nucleus," || or that by Treub and Strasburger as "fragmentation." For this purpose he used chiefly the apical cells and primary segment-cells of the stem, those of the so-called "pro-embryo," of the leaves and cortical lobes, and of the nodes, employing the methods of hardening and colouring by means of picric acid and hæmatoxylin.

The results obtained were in many respects different from those previously described by Schmitz, Treub, and Strasburger, a difference which the author suggests may be explained by the fact that the various observers have had under observation different species or varieties of *Chara*. The "fragmentation" which Strasburger describes was also not observed by Johow in the staminal hairs of *Tradescantia*, the parenchymatous cells of *Nicotiana* and *Tropæolum*, or the suspensor of *Orobus*. The following are the chief points on which he insists.

The cell-nucleus of *Chara fœtida* retains the same structure in essential points throughout its existence, viz. a homogenous matrix in which are imbedded chromatin-particles of varying number and form; the occurrence of the nuclear wall is not limited to any particular stage. A disorganization of the cell-nucleus did not accom-

* Bot. Centralbl., vii. (1881) pp. 345–9.
† Ibid., pp. 311–19.
‡ See this Journal, i. (1881) p. 773.
§ Bot. Ztg., xxxix. (1881) pp. 729–43, 745–53 (1 pl.).
|| See this Journal, i. (1881) p. 475.

pany or follow the fragmentation; on the contrary, the multiplication of the nuclei was accompanied by a considerable increase in size of the chromatin-particles and of the matrix. The same was the case with the cell-nucleus of Phanerogams. The division of the nucleus in the cell-division of *Chara fœtida* is completed in a manner very different from the later multiplication of nuclei, and presents also but little resemblance to the mode of division in most animals and plants. But in the older nuclei there is a considerable series of transitional forms in the same plant, to the most simple mode of division by means of external constriction of the nuclear mass without internal differentiation.

There appears to be no essential morphological distinction between karyokinetic division and fragmentation.

Fungi.

Conidial Apparatus in Hydnum.*—Ch. Richon describes what he considers to be a hitherto undetected reproductive apparatus in *Hydnum erinaceum*. It resembles that described by M. Cornu in *Ptychogaster albus*, and consists of intracellular conidia in the parenchyma, situated in the superior zone of the receptacle, and prolonged into the median zone. Instead of being produced at the extremity of cells of the parenchyma, they are formed and develope in the interior of the cells. They vary in size from 6–7 μ in diameter, being usually ovoid, less often rod-shaped. Conidia of somewhat similar origin are found in *Fistulina hepatica*, *Polyporus sulfureus*, and *Corticium dubium*.

Alternation of Generations in Uredineæ.†—E. Ráthay confirms Winter's observation that the *Cæomata*, on roses, potentillas, and the raspberry, are the æcidial forms of *Phragmidia;* he found spermogonia on them. The test of an æcidial form he considers to be not the envelope or the chain of spores, but the presence of spermogonia. He regards *Melampsora populina* and *Æcidium Clematidis* as probably developmental forms of the same species.

Mode of Parasitism of Puccinia Malvacearum.‡—The mode in which the germinating filaments from the sporidia of *Puccinia Malvacearum* penetrate the host has been variously stated to be through the stomata, and through the cuticle where the lateral join the superficial cell-walls. E. Ráthay finds that though the latter is often the case, they frequently perforate the epidermal cells at a point distant from any lateral wall.

Sterigmatocystis.§—Cramer first described this genus of fungi from *S. antacustica*, found in the ear of a deaf person. M. Bainier now gives the characters of six new species:—*S. usta*, *ochracea*,

* Bull. Soc. Bot. France, xxviii. (1881) pp. 179–82 (1 pl.).

† Verhandl. zool.-bot. Ges. Wien, Jan. 5, 1881. See Bot. Centralbl., vii. (1881) p. 164.

‡ Verhandl. zool.-bot. Ges. Wien, Dec. 1, 1880. See Bot. Centralbl., vii. (1881) p. 163.

§ Bull. Soc. Bot. France, xxviii. (1881) pp. 76–9.

quercina, *aerea*, *Helva*, and *fuliginosa*. They are found on all sorts of ternary compounds, starch, dextrine, sugar, paper, tannin, &c., and may be cultivated on gelatine, gluten, and bread, but not apparently on meat. They are extremely abundant on grapes, and on other edible commodities, the species being especially *S. nigra*, *carbonaria*, and *fuliginosa*, while *S. glauca* is found in wine. Glycerin is extremely prejudicial to their growth, and may be used to prevent their appearance. The spores have a great power of resistance to cold; and, when once established, these moulds are very difficult to extirpate.

Oospores of Phytophthora infestans.*—M. Cornu has reinvestigated the vexed question of the oospores of *Phytophthora* (*Peronospora*) *infestans*, which have not yet been recognized with certainty. The bodies described by W. G. Smith as the sexual spores of the *Phytophthora*, Cornu agrees with de Bary in regarding as in reality the oospores of a *Pythium*. Caspary and Berkeley, on the other hand, regarded as the true oospores of *Phytophthora* the bodies described by Montagne under the name *Artotrogus hydnosporus*, a conclusion doubted by de Bary on the ground of their alleged identity with similar bodies found on the turnip. Cornu shows, however, that this latter parasite is altogether different from that of the turnip. The bodies described as *Artotrogus* are of two kinds, one echinated, the other not. The former of these Cornu considers in all probability to be the oospores either of *Phytophthora*, or of some *Saprolegnia* at present unknown.

Peronospora viticola.†—E. Prillieux, after pointing out the known existence of conidia or summer-spores, and oospores or winter-spores, states that he has been able to convince himself, during the course of a mission undertaken under the instructions of the Minister of Agriculture, that there is no doubt as to the "prodigiously abundant formation of winter-spores" in various parts of France. The quantity of these small bodies which may be found in one dry leaf appears to be enormous (200 per square millimetre). Not much harm is done in dry weather, but when the seasons are wet the author thinks that all the vine-leaves should be collected and burnt.

Vegetation of Fungi in Oil.‡—P. Van Tieghem some years since observed the development of flakes of mycelium in a bottle of olive oil; this was due to two germs; one not cultivable on slices of potato, the other identified as very nearly allied to *Verticillium cinnabarinum*. Immersion of seeds or pieces of the higher plants, covered with mycelium growth, in the same medium, and placing in an atmosphere at about 25° C., produced after a few days a plentiful growth of mycelium over these bodies, on the surface of the oil, and at any points at which spores had been left in contact with the air. It is established that the oil is absolutely necessary to the life of the

* Bull. Soc. Bot. France, xxviii. (1881) pp. 102–9.
† Comptes Rendus, xciii. (1881) pp. 752–3.
‡ Bull. Soc. Bot. France, xxvii. (1880) p. 353.

fungus; it will not develope in linseed oil, colza oil, or water, and is killed if transferred from olive oil to any of these liquids. If the mycelium is removed from the plants before being transferred to the oil, its development is very slow, and fructification is not obtained; this is probably due to the want of the water which the plant contained. The systematic position of the form could not be determined.

He also finds as the result of subsequent investigations* that a number of mycelia flourish in a variety of oils, as those of olive, poppy, linseed, and colza, and in castor-oil. Most of these are still undetermined, and one appears to be a species of *Verticillium*. Among those which appeared in olive-oil is a new *Saccharomyces*, to which he gives the name *S. olei*. It consists of oval cells arranged in branched threads, which occasionally become broken up, and the isolated cells then bud and form new threads. The average size of the cells is $4 \cdot 0\ \mu$ by $2 \cdot 5\ \mu$; their contents of a pale or, in refracted light, of a slight rose colour. No disengagement of gas, or special odour, accompanies their growth. At length they form a farinaceous deposit at the bottom of the water. The nature of the oil is completely changed in the process, becoming white and milky in the course of about eight days. Neither *S. cerevisiæ* nor any other allied species will grow in olive-oil.

A moneron grown in the same way in castor-oil developed through the whole substance of the oil, rendering it opaline; it does not, however, change its nature or saponify.

If into any oil that has not been purified any body is introduced which has been soaked in water, the surface of the body is seen, after a few days, to be covered with an abundant vegetation, composed of the mycelia of a number of fungi, among which have been detected *Mucor spinosus* and *pleurocystis*, and species of *Verticillium*, *Chætomium*, and *Sterigmatocystis*, but most abundantly of all, *Penicillium glaucum*, which fructifies profusely, not only on the surface, as is the case with aqueous solutions, but throughout the oil. Other Ascomycetes produce not only their conidia, but also their perithecia in these conditions. These fungi are produced in a great variety of unpurified oils, but not in an oil which has been purified by sulphuric acid like colza-oil, or which has been strongly heated, like linseed-oil. If the moist substance is placed for a time in boiling water before its immersion in the oil, it still becomes covered after a time with the fungoid growth, showing that the spores are in the oil and not in the moist substance; the reason for their not developing in the oil, if left to itself, being that water is necessary for their growth. The plant obtains its necessary oxygen and nitrogen from the air dissolved in the oil; the oil itself furnishing direct to the plant the carbon and the hydrogen. A sufficient quantity of nitrogenous and mineral substances is always contained in unpurified oil. The oil remains perfectly limpid, and apparently does not undergo any change in composition, except a crystallization of fatty acids, indicating a slow saponification.

* Bull. Soc. Bot. France, xxviii. (1881) pp. 70–1, 137–42.

Parasitic Fungi.*—M. Cornu notices the occurrence of two parasitic fungi on hosts not previously observed, *Cylindrospora nivea* on *Veronica arvensis*, and a uredo, probably belonging to the cycle of generation of *Æcidium nitens*, on an unnamed American *Rubus*.

Ear-Fungi.†—Fr. Betzold has detected the following species of Hyphomycetes as accompaniments of diseases of the ear, viz. *Aspergillus nigricans*, *flavescens*, and *fumigatus*, and *Trichothecium roseum*. He does not regard these fungi as saprophytes, but as the actual cause of inflammation.

Insect-destroying Cryptogam.‡—J. Lichtenstein calls attention to a very curious case of parasitism, namely, the presence in the hot-houses of the Jardin des Plantes, at Montpellier, of an "insecticide cryptogam" (a *Botrytis*), which killed all the aphides on a *Cineraria*.

The action of the parasite would appear to cease in the open air, at least the author was unable to inoculate with it either the *Phylloxera* or an Aphis (*Chaitophorus aceris*). Perhaps, the author speculates, direct inoculation is impracticable, and there may exist an intermediate stage on other creatures, as in *Entomophthora* and other Cryptogams.

Brefeld's Schimmelpilze.§—The fourth part of O. Brefeld's general work on mycology treats of the moulds or Schimmelpilze, and is introduced by some general remarks on the cultivation of microscopic fungi. He especially recommends the use of Geissler's modification of Recklinghausen's chamber, which has special advantages for the culture of single specimens.

The life-history of *Bacillus subtilis* is described in detail, followed by that of *Chætocladium Fresenianum*, parasitic upon *Mucor* and *Rhizopus*, but which will readily grow in nutrient fluids, and can easily be made to produce zygospores. Two new species of *Thamnidium*, and one of *Mucor*, are also described. He regards as the ancestor of the Zygomycetes a form with one kind of sporangium, from which sprang the Thamnidieæ with sporangia and sporangioles. Thence were derived various branches:—by the reversion of the sporangioles to forms with single conidia; by the separation of the sporangioles and conidia to separate receptacles, to the Choanephoreæ; by the abortion of the sporangia to the Chætocladiaceæ.

Under the head of *Pilobolus*, a special description is given of *P. anomalus*, in which large portions of the mycelium, divided off by septa, produce each a receptacle; a division in the young sporangium after the formation of the columella leads to the production of the sporiferous portion and the swelling-layer, which, after first becoming dry, then absorbs water, swells up, and separates the sporangium from the pedicel. The author has, in this species, observed germinating

* Bull. Soc. Bot. France, xxviii. (1881) pp. 143–6.
† 'Zur Aetiologie der Infectionskrankheiten,' 1880, pp. 95–109.
‡ Comptes Rendus, xciii. (1881).
§ Brefeld, O., 'Unters. aus dem Gesammtgebiet der Mykologie. Heft 4. Bot. Unters. über Schimmelpilze.' 191 pp. (10 pls.). Leipzig, 1881.

zygospores in the ordinary receptacles. Very different is the origin of the receptacle in five other species of *Pilobolus*, in which only a single short tuberous piece is divided off from the mycelium by a septum, the receptacle being produced entirely in this. The energy of the process by which the spores are thrown out is in inverse proportion to the length of the pedicel. The author was unable to find zygospores in these species, and believes the sexual mode of reproduction to have fallen, with them, partially into abeyance. The production of the receptacle of *Pilobolus* is greatly dependent on light.

Descriptions follow of other Zygomycetes, *Sporodinia grandis* and *Mortierella Rostafinskii*, the latter of which is found on horse-dung. The short mucor-like receptacles are formed on short stolons, and are usually fixed to the substratum by thick bundles of rhizoids at the base of the receptacle, often enveloping it, and thus forming a tissue composed of unseptated filaments, resembling a capsule, and about one-fourth the height of the receptacle, the sporangium being exserted from its apex. The outer portions of this structure are of a yellowish or brownish colour, and are cuticularized, the sporangia remaining white even when mature. The sporangia are not produced from the entire apex of the fertile hyphæ, but only from a small central zone, a peculiar constriction being formed beneath them. When the spores have been formed out of the protoplasm, a division-wall separates the sporangium from the pedicel without the formation of a columella. As the spores are developing, the walls of the upper part of the pedicel become thicker, as also does the basal part of the wall of the sporangium, which remains behind like a collar when the upper part has become separated and the spores have escaped. In old cultures, or those which have been disturbed, gemmæ often made their appearance, as in *Mucor racemosus*. In very poor nutrient fluids, the number of spores was reduced from many thousands to two or four, and the rhizoids were entirely wanting. After long-continued culture, and the succession of from ten to twelve generations, the production of non-sexual receptacles almost entirely ceased, and zygospores only were produced, enclosed in large brown capsular tissues. In other instances, however, this envelope was wanting.

The nature of the sporangium and the conidia derived from it are used by Brefeld as the foundation of the classification of the Zygomycetes, which he divides into five families, viz. Mucorineæ, Thamnidieæ, Choanephoreæ, Chætocladiaceæ, and Piptocephalideæ.

In *Entomophthora radicans*, Brefeld describes the formation of the resting-spores, from which he concludes that the Entomophthoreæ form a small family more nearly allied to the Ustilagineæ than to the Peronosporeæ, being most nearly connected with the former through *Entyloma*. In both families he considers the resting-spores to be oogonia, in which the formation of spores is suppressed, and the oogonium itself has become a spore. Their natural position is therefore in the Oomycetes, near to the Phycomycetes. Two new species of *Empusa* are described, one parasitic on flies, the other on gnats.

The formation of both conidia and sclerotia is followed out with care in *Peziza tuberosa* and *sclerotiorum*, and the view is confirmed that there is no causal connection between the two. The sclerotia always proceed from a mass of hyphæ which put out abundance of shoots, and are more slender than other mycelial filaments. As soon as they begin to coil and interweave, a general lateral branching takes place, which gradually fills up all the air-cavities in the ball, and unites the hyphæ with one another. The sclerotia retain their power of germination for years, if kept dry. They then put out thick greyish-yellow club-shaped bodies composed of nothing but hyphæ, which grow by apical growth and finally become the fertile cups, the apical growth ceasing at the middle, while the peripheral filaments continue to grow and branch abundantly. After growth in length has ceased, a layer of paraphyses is formed gradually from the middle towards the margin, the asci being then formed, their formation continuing after the expulsion of the first spores. The ascospores, eight of which are contained in each ascus, are 8 μ broad and 12 μ long. They germinate at once, and form ordinary mycelia with sclerotia. In the autumn the club-shaped bodies often form secondary clubs, even to several generations, which produce cups in the next spring. If the clubs are covered with a small quantity of earth, they produce much-branched strings of Rhizomorpha, on which new clubs appear at all points. In certain circumstances the branches of the paraphyses develope into receptacles with conidia; they often make their appearance in the cups as forerunners of the ascogenous layer.

On the sclerotia of these two species of *Peziza* there often appears a pycnidial form which interferes with the formation of the cups. Cultivation produced no other form of this fungus, which Brefeld calls *Pycnis sclerotivora*. The germination and formation of the mycelium and abstriction of the spores are described in detail.

With regard to other Ascomycetes, he finds the processes similar in all essential points in *Peziza cibarioides*, *Fuckeliana*, *coccinea*, and *aurantia*, *Otidea leporina*, *Sarcosphæra macrocalyx*, *Leotia lubrica*, *Geoglossum*, *Morchella*, and *Helvella*; except that in the last two genera no conidia were observed, and in *Peziza Fuckeliana* the attempt was unsuccessful to obtain from the *Botrytis*-spores perfect sclerotia which developed into cups. All the above-named agree in this point, that the differentiation of the hyphæ into sterile and fertile takes place only when the receptacle has nearly reached maturity. In other forms, as *Ascobolus denudatus*, *Erysiphe*, *Eurotium*, *Penicillium*, *Melanospora*, and *Xylaria*, this differentiation takes place at a very early period. In the first of these, after several generations, large masses of thallus arose out of scolecites. In some instances the formation of conidiophores precedes or accompanies that of the receptacles; but they may be altogether wanting. Brefeld considers the so-called "pollinodia" to have no other function but that of enveloping tubes; the conidia and receptacles are therefore of non-sexual origin.

In three small Ascomycetes grown on hare's dung, one of which resembled *Ryparobius myriosporus*, the formation of the asci could be

traced back to a single cell or ascogenous filament, as also was the case in *Melanospora*, the perithecial form of *Botrytis Bassiana*.

As regards the general structure and position of the Ascomycetes, Brefeld regards the three following as the most important points:—1. The degradation of the various forms of fructification; 2. The disappearance of sexuality, either from the forms of fructification or with them; 3. The reversion of sporangia to conidia. All known fungi he divides into the two great divisions of Phycomycetes and Mycomycetes. To the Phycomycetes belong two classes, viz.:—1. Zygomycetes (Mucorineæ, Thamnidieæ, Choanephoreæ, Chætocladiaceæ, and Piptocephalideæ); and 2. Oomycetes (Chytridiaceæ, Saprolegnieæ, Peronosporeæ, Entomophthoreæ, and Ustilagineæ). The Mycomycetes are composed of three classes, viz.:—3. Ascomycetes; 4. Æcidiomycetes; and 5. Basidiomycetes. The lowest forms of fungi he regards as nearly related diverging branches from a common origin. The same is the case also with the higher forms. In both higher and lower forms he finds the same tendency for the sporangia to revert to the condition of simple conidia, and for the fructification to lose its sexuality.

The multinucleated condition of the cells of many unicellular Thallophytes Brefeld regards as an indication that they are descended from multicellular forms from which the cell-walls have disappeared. The family in which this degradation has been carried to the greatest extent is the Myxomycetes, constituting a third great division of the Fungi, in which the cell-walls even of the spores have disappeared, the vegetative life being carried on by permanently naked cells.

Both the higher and lower Fungi may be traced back to a sporangiferous parent-form, probably green and belonging to the Algæ, in which there was already a differentiation into sexual and non-sexual forms of fructification. Sexuality was therefore the original condition of all Fungi, but has in many cases disappeared, a phenomenon not seen elsewhere in the vegetable kingdom. All three forms of fructification, or only some, or none, may have degenerated to the condition of conidia. Hence we may get forms with only male, others with only female organs. The number of forms of fructification may also be increased beyond three, as in the Æcidiomycetes. There may also be in addition a pure vegetative mode of increase, by the breaking up of the mycelium, or the separation of shoots. In these cases all other modes of reproduction, all kinds of fructification, may disappear, and propagation take place in a vegetative way only.

The pollinodia of the Ascomycetes not having the male character assigned to them by de Bary, Brefeld regards the ascocarp as an originally female mode of fructification which has lost its sexual character; the spermatia indicating, in their inability to germinate, their original male character. The conidia are the result of degradation of the asci. In the Erysipheæ, Pyrenomycetes, and Discomycetes, the apothecia or perithecia may, from analogy, be regarded as similar degraded female organs; in the ascophores of *Exoascus* and *Taphrina* both sexual and non-sexual forms of fructification occur.

If the ascus is to be regarded as a sporangium, and the conidia as degraded asci, it is clear that no great stress should be laid, from a systematic point of view, on the higher differentiation of the fructification, its development into a carpospore, &c. A relationship of the Ascomycetes may then be traced downwards with the Phycomycetes, upwards with the Æcidiomycetes and Basidiomycetes. In the ascus or sporangium is the point of connection with the lower Fungi, in the conidia or degraded sporangia that with the higher Fungi; while the sporangium further indicates the descent of all the Fungi from Algæ.

Influence of Light on the Growth of Penicillium.*—In his experiments on the growth of Fungi in oil,† P. Van Tieghem observed that the development of *Penicillium glaucum* is powerfully affected by light. It is only in the spots that are strongly illuminated that the mycelium developes into a continuous coating, very little or none appearing on those that remain dark.

Production of Microphytes within the Egg.‡—G. Cattaneo has lately occupied himself with the solution of the question whether the fungi which so frequently develope within bird's eggs are introduced into the egg from without or whether, as is held by a number of Italian investigators to be the case with regard to the Schizomycetes, they may arise independently within the egg, out of its own constituent elements. A preliminary consideration of the ways by which the spores might enter the egg while still in the body—namely, by the lungs and air-sacs, by the alimentary canal, and finally by the cloaca and oviducts—leads the author to the conclusion that it is most unlikely that the spores should enter the developing egg by these routes. Thus the development of fungi in eggs shortly after they are laid is probably not to be referred to spores introduced from without, even though the fungi should sometimes enter through the egg-shell. His own observations on the development of fungi within and upon eggs, which were carried on in a moist chamber, in part upon eggs covered with a coat of wax or copal varnish, led to the result that the growths of *Penicillium*, *Aspergillus*, &c., which often develope in such abundance on eggs thus treated, seldom pass into the interior, and have not the power of penetrating the skin of the shell; and that, on the other hand, the growths of *Leptothrix* and *Leptomitus* which spring up only in eggs which have not become decomposed, are produced on the inner side of the skin of the shell, and manifest centrifugal growth outwards through the pore-canals of the egg-shell, without showing any indication of an entrance from outside.

Ætiology of Diphtheria §—Oertel believes the contagium of diphtheria to be an excessively minute organism, to which he gives the name *Micrococcus diphtheriæ*. It has an oval form, with a length of

* Bull. Soc. Bot. France, xxviii. (1881) p. 186.

† See *ante*, p. 81.

‡ Atti Soc. Ital. Sci. Nat., xx. (1 pl.). Cf. Zool. Jahresber. Naples, i. (for 1879) p. 123.

§ 'Zur Aetiologie der Infectionskrankheiten' (1881) pp. 199-246. See Bot. Centralbl., vii. (1881) p. 269.

1–1·5 μ, and a breadth of 0·3 μ; larger individuals, found nearer the surface, being 4·2 μ long and 1·1 μ broad. Where the individuals are more scattered, they occur mostly in pairs, rarely a number connected into a torula-like chain. When present in masses the cells lie so close together that it is difficult to determine whether they are connected or not. They are then imbedded in a gelatinous envelope, and thus combined in masses into a colony. Addition of acetic acid makes the mass clearer, so that the combination in pairs and the more rod-like form of the separate cells is more readily seen. These organisms penetrate the epithelium. They are found chiefly in the mouth and throat; and may be conveyed through the air, by direct contact, through the saliva, or by contact with a great variety of objects, as plates or drinking glasses, clothes, toys, linen, &c. The most favourable nidus for their development and fatal activity is when, from injury to the cuticle, they come into direct contact with the blood and tissues.

The author believes the micrococcus to be specifically distinct from those which produce other infectious diseases. The apparent spontaneous production in some cases of diphtherial disease may arise from the germs being present in some other organism in a different form, in which it is incapable of producing disease, or from its being present in the infected subject in a latent condition, waiting favourable conditions for its development. The average length of time through which the disease runs before reaching its culmination may be stated as from two to five days.

Properties and Functions of Bacteria.*—Prof. J. B. Schnetzler finds that Bacteria, as well as Infusoria of the genus *Vorticella*, live and exhibit activity in a solution of curare; moreover the muscles and cilia of the Turbellarian *Planaria torva* and some of the muscles of *Gammarus pulex* were found to act with energy after being exposed to the same reagent for twenty-four hours. But *Bacillus subtilis* is killed immediately by perchloride of iron solution. The bacteria produced during decomposition of a plant do not produce fatal results when injected into the vessels of a rabbit. Prof. Schnetzler shows that a highly organized plant may be watered exclusively by a fetid liquid full of bacteria, without undergoing fermentation or decomposition of its parts; the bacteria (*Micrococcus* and *Bacillus*) may be found in the leaves, but they also occur in those of plants which have been watered with ordinary water.

Finding bacteria in the condensed moisture which appears on the cover of a vessel containing bacteria and green algæ, Prof. Schnetzler explains their appearance there by the bursting of the bubbles of oxygen which rise to the surface under the influence of sunlight and in bursting scatter the bacteria which they have brought up with them.

Atmospheric Bacteria.†—Continuing his previous investigations, on this subject,‡ P. Miquel gives the averages since obtained by him,

* Bull. Soc. Vaudoise Sci. Nat., xvii. (1881) pp. 625–32.
† Bull. Soc. Bot. France, xxviii. (1881); Rev Bibl., p. 11.
‡ See this Journal, iii. (1880) p. 837.

showing for each month the quantity of spores in the air of Montsouris, and describes some interesting facts concerning the cultivation of bacteria.

Bacillus ureæ, cultivated in neutral bouillon, falls to the bottom of the vessel, and dies, leaving the liquid perfectly transparent; but if a little pure urea is added when the parasite is living, the fluid becomes cloudy and charged with carbonate of ammonia. Of all the species cultivated by the author in a state of purity, none abandoned their special aptitudes nor departed from the cycle of evolution proper to each. Certain illusions and analogies are therefore to be guarded against. *Bacilli*, in the absence of oxygen, can assume a resemblance to *Bacteria*, and *Bacteria* when dead are easily confounded with *Micrococci*.

Pathogenous Bacillus in Drinking Water.*—J. Brautlecht has detected in drinking water, which was considered to be the partial cause of an epidemic of typhus, a bacillus which he cultivated in a solution of 3 per mil. gelatine in spring water, with 25 per cent. ammonium phosphate. This was distinguished from other non-pathogenous bacilli by the absence of any powerful reducing action and also of the offensive odour of some other species; having a pleasant odour somewhat like that of boiled milk. This bacillus forms filaments in the nutrient fluid, which soon break up into short rods, which separate into cocci loosely connected in a moniliform manner. In later cultures only rods and cocci were visible, which did not exhibit any spontaneous motion. Besides the suspected drinking water, a bacillus with the same characteristics was found in the urine of typhus patients, also on the surface of thick masses of putrefying algæ. When inserted beneath the skin of a rabbit, these bacilli caused violent fever in from 18 to 36 hours.

Connection of Diseases with specific Bacilli.†—H. Buchner describes a series of experiments for the purpose of determining whether contagious diseases are caused entirely by the bacilli which are found to accompany them, or whether the action of these is assisted by a peculiar chemical substance resulting from the diseased tissue. The results pointed entirely in the direction of the first of these hypotheses. It was found in the first place that the cattle disease was produced by bacilli originally taken from diseased subjects, even when these had been cultivated to thirty-six generations, when it was impossible for the least trace of any disease-producing substance to exist which had come directly from the diseased subject. In the second place, it was found, after repeated and long-continued culture, that these disease-producing bacilli differed in no visible respect from the bacilli produced spontaneously in hay; while with the latter he was able to produce the disease by injecting it into the blood of white mice and rabbits.

* Virchow's Arch. path. Anat., lxxxiv. p. 80. See Naturforscher, xiv. (1881) p. 320.

† 'Zur Aetiologie der Infectionskrankheiten,' 1881, pp. 69–94. See Bot. Centralbl., vii. (1881) p. 237.

Origin of the lowest Organisms.*—F. Krasan, in an extraordinary production published in the Transactions of a learned Society as a serious paper, discusses the hypothesis of a possible archibiosis in the case of the lowest organisms, and supports his opinion in favour of this mode of origin in at any rate a spirited manner by the results of a series of experiments. He does not contest the argument that many of the lowest forms arise from such germs as may be contained in dust, but insists that the proof of such an origin is much hindered by the mechanical difficulties of manipulation. The experiments are divided into three series :—

1. Relations of *Bacteria* to certain microscopic structures contained in the seeds of many plants, and the action of phosphate of hydrogen, soda, and ammonia (microcosmic salt) and atmospheric dust :—

The close connection alleged to exist between bacterian movements and the molecular movements of organic particles is illustrated by the phenomena exhibited by drops of oil derived from seeds, such as those of the parsnep and of melons and gourds, also hazel-nut kernels, broken up in water (either distilled, stream, or spring water). These drops are of different sizes, and generally contain vacuoles filled with water, coloured pale red, and each surrounded by a bluish-green halo, the whole mass being greenish-grey or pale green; they consist of a mixture of oil, albumen, and a carbohydrate. If one of the superficial vacuoles is closely examined, it is seen to contain an immense number of very minute roundish bodies in rapid movement of a swarming character. The vacuole increases in size by pushing its way to the exterior, where it finally bursts, discharging its contents into the surrounding water; a small portion remains, and is enclosed by the collapsed oil-globule. The minute bodies thus liberated move towards the edge of the cover-glass, and at the same time approach each other in pairs, and after rotating very rapidly become quiescent and unite, forming cylindrical masses. These are considered by the writer to be half-formed bacteria, and they are said to be almost identical in appearance with true bacteria, but differ in possessing the property of dichroism, which becomes more marked towards the edge of the glass, and is probably, together with the phenomena of conjunction, connected with the proximity of the air. These bodies may be dried, and yet resume their characters when again moistened.

The following differential experiments were undertaken. To equal parts of a $5\frac{1}{2}$ to 6 per cent. solution of sugar in distilled water was added a rather smaller proportion of gypsum or freshly burned coal-ash (rich in sulphate of lime); to one-half of the mixture was added 20–40 milligrams of atmospheric dust, to the other half 4–8 milligrams of the phosphate salt; both were stirred, covered, and set aside in a temperature of 10°–14° C. In 48 hours the dust-containing mixture contained isolated bacteria in active movement, while the other showed quantities of them, forming groups on the air-bubbles; thus a small amount of the phosphate salt was more pro-

* Verh. zool.-bot. Ges. Wien, xxx. (1881) pp. 267–327 (1 pl.).

ductive of bacteria than five times its proportion of atmospheric dust; in the latter case the forms are chiefly *Bacterium lineola*, in the former *B. termo;* this difference bespeaks a different origin for the two growths.

Solution of sugar and the microcosmic salt and coal-ashes in distilled water produced no bacteria in 28 hours after addition of dust, and but few when left to itself, but with a drop of bacterian liquid it contained abundance, arranged in tracts; in 45½ hours the condition was essentially the same, but after 68 hours the dust preparation contained an abundance in masses; also the uninfected solution, but here development appears to have begun four or five hours later than in the dust preparation.

Pieces of an almond more than two years old were boiled for a minute in distilled water, and the decoction put while hot into 9 watch-glasses, "cleaned, as usual, as well as possible," and covered up. The contents of these glasses were variously treated, with the following results:—

No. 1. Left untouched; developed a yeast-fungus and some mycelia, after the lapse of 22 days.

No. 2. Similarly treated; was filled with mould and fermentation fungi after 13 days.

Nos. 3, 4, and 5, having received, the one 2 grams, the other a drop of distilled water, the third a drop of emulsion of almond kernel in distilled water, were clouded with a minute bacterium in 48 hours.

No. 6 received two pieces of almond, and began to be clouded with a bacillus in 70 hours.

No. 7, infected from an emulsion full of bacteria, swarmed with the same form in 24 hours.

No. 8, which had received a few milligrams of atmospheric dust, showed some larger bacteria, some being united into rods and chains, after 44 hours.

No. 9 was infected with a dried-up drop of bacterium liquid, and became cloudy in 40 hours.

From these and similar experiments Krasan concludes, first, that heat disorganizes the molecules of organic substances so as to render them incapable of becoming rearranged into organic structures without the stimulus of fresh air or other agents; secondly, this stimulus need not proceed directly from organic germs strictly so called, but may just as well be derived from the fresh air itself. Water and various liquid and solid organic substances are employed, which are either unaltered by heat, or else have been long in contact with fresh air.

Krasan considers the possible inorganic origin of low organisms absolutely proved by his finding them developed first in the *Micrococcus-*, then the *Zooglœa*-form in a precipitate of calcium phosphate in calcium sulphate solution to which sugar had been added; he has observed them to arise from minute granules which occur in the freshly formed precipitate, and considers it due to decomposition of the sugar molecules and recombination of their radicals with the other constituents.

2. *Development of Monads.*—Under this term are here included only low organisms of the form of swarm-spores, about 4 micro-millimetres in diameter. These become very slow in their movements, and proceed to reproduce by fission in very concentrated emulsions, but when transplanted to a dilute liquid become very active, and exhibit the peculiarity of attracting particles of various sizes and expelling them again with vigour, a process set down to an electric energy, residing in its greatest power at the base of the flagellum. Investigations extending over two years failed in discovering another mode of increase but that by fission. Repeated experiments, however, of which the object—viz. that of discovering a method of genesis which dispenses with any antecedent organism—is not concealed, were, so the author relates, at length rewarded. Some " aleuron-granules " from hazel-nut kernels mashed-up in water, were observed to resolve themselves into granular jelly-masses of globular form; from this mass the monad is said to develope, or several may arise from a single mass. A large monad with a proboscis was seen to arise from an aleuron-granule by fission of its substance and extension of the gelatinous material at two opposite points, forming a fusiform body; if the formative mass is larger than the normal monad it divides and forms two. Oily drops of protoplasm also become converted into monads. The production of these organisms is dependent on the time during which the seed has been left to dry in its shell. Monads were also produced from a mixture of sugar and stream or spring water and a phosphate, by contraction or fission of the flocculent precipitate contained in it. Two sizes of monads are produced from a solution of Umbelliferous seeds in spring water; the larger are derived from the smaller. Ciliated Infusoria are said to have been seen to develope from zooglœa-masses; the process occurs in the early morning, between 1 and 4 A.M. (!) *Leucophrys* is generated with especial ease from water, sugar, and a phosphate. Thundery evenings in August and September are the best times for such developments to occur; monads and ciliated Infusoria are mutually exclusive, and do not develop from the same solution.

3. *Effects of Contact* are the subject of the third and last series of investigations. Krasan finds that the development of bacillus in infusions of seeds in boiling water is almost entirely dependent on the retention in the fluid of the solid bodies used to make the infusion; but that the presence of all kinds of solid bodies in infusions of other kinds considerably facilitates and is indispensable to their development; the result of this is thus stated. (1) Solid particles and heterogeneous bodies in a solution of formative organic substances exercise a favourable influence on the process of formation by their presence, and being in contact with the solution, inasmuch as they accelerate the interchange of matter, and give a definite direction to the organizing activity of the molecular forces. (2) The nature of the foreign bodies is not without influence on the size, form, consistence, colour, and mobility of the organisms which are produced.

The author invokes the action of physico-chemical forces in

aid of his theory, and explains the phenomena on which he based it; chiefly appealing to the different electrical polarities of the substances employed—a line of argument familiar to most of those who have studied the question of the origin of life.

It is to be observed, in estimating the scientific value of these experiments, that the highest magnifying power mentioned as being employed is 610 diameters, and that as a rule no special attention appears to be given to the cleaning of the vessels, or the sterilizing of the air or water, the latter being as often ordinary spring- or stream-water as distilled. The value of the reasoning is still further impaired by the fact that the latest experiments which have been adduced in opposition to the ancient theory here advocated afresh are dismissed without much consideration, even those of Tyndall receiving but scanty attention.

Prolongation of Vegetative Activity of Chlorophyllian Cells under the influence of a parasite.*—According to the Schwendenerian theory lichens are complex organisms, consisting of an alga, and a fungus which is parasitic on it. It seems extraordinary that the alga, thus embraced by a parasite, not only continues to live, but increases and multiplies, and is apparently endowed with new vigour. The same alga, alone, becomes discoloured and disappears on the return of the dry season; but in the lichen state it often persists for years. It has been said by Rees, that there are no other such cases known of vegetative activity being prolonged under the influence of a parasite; but Max Cornu has lately called attention to several. Thus, maples are often attacked, late in summer, by an *Erysiphus* which occupies the under surface of the leaves. The parts thus occupied remain green when the rest of the leaf has withered, and even after the leaf has fallen. Similarly with a parasite which attacks leaves and fruits of pears, apples, &c.; indeed, the fact is very general; the chlorophyll-cells attacked retain their green and their vital activity longer than the others. The phenomenon is explained by the fungus counter-balancing the return of nutritive matters towards the reserve centres. Green algæ have a vegetative period, during which they retain this colour very intensely; then they grow yellow and form durable spores, after which the vegetative part dies. In lichens the fungus prevents this development of spores, and so favours the life of the alga. Flowering annuals similarly may be preserved many years by prevention of flowering.

Algæ.

Classification of Nostoc.—In the second fasciculus of MM. Bornet and Thuret's 'Notes algologiques,' M. Bornet gives a full life-history of the genus *Nostoc*, including the germination of the spores and the development of the hormogonia, which display motility after their escape. The thickening of the filaments takes place in many species, without having any specific value. With *Nostoc* M. Bornet

* Comptes Rendus, xciii. (1881). See also Mr. P. Geddes' recent researches on "Animal Lichens," 'Nature,' xxv. (1882) pp. 303-5.

unites *Monormia* Berk. and *Hormosiphon* Kg., and distinguishes the following groups and species.

1. *Intricata.* Aquatic, softly gelatinous, without definite form, often floating:—*N. Hederulæ* Men., *tenuissimum* Rbh., *Linkia* Roth., *intricatum* Men., *crispulum* Rbh., *piscinale* Kg., *carneum* Ag., *rivulare* Kg.

2. *Gelatinosa.* Fixed; soft and gelatinous. Cells of the young filament elongated cylindrical. Spores large, elongated:—*N. spongiæforme* Ag., *gelatinosum* Shousboe, *ellipsosporum* Rbh.

3. *Humifusa.* Terrestrial. At first globular, afterwards coalescent and gelatinous, forming coatings adherent to the substratum. Spores smooth:—*N. collinum* Kg., *muscorum* Ag. var. *tenax* Thur., *Passerinianum* De Not., *humifusum* Carm., *calcicola* Bréb., *foliaceum* Morg.

4. *Communia.* Terrestrial, occasionally aquatic. At first globular, subsequently tongue-shaped, flat and irregular, not attached to the substratum:—*N. cimiflorum* Tourn. (*commune* Vauch.).

5. *Sphærica.* Globular, or often irregularly round when they grow larger. Surface firm and resistent:—*N. sphæricum* Vauch., *rupestre* Kg., *macrosporum* Men., *sphæroides* Kg., *cæruleum* Lyngb., *minutissimum* Kg., *gregarium* Thur., *edule* Mont., and Berk., *pruniforme* Ag.

6. *Verrucosa.* Aquatic; rounded or disk-shaped, at first solid, then hollow, protected by a firm tough membrane. Filaments delicate, distant, and somewhat curved in the middle, crowded and much bent at the ends:—*N. verrucosum* Vauch., *parmelioides* Kg.

7. *Zetterstedtiana.* Aquatic; globular, hard, warty, divides readily into separable segments:—*N. Zetterstedtianum* Aresch.

8. *Flagelliformia.* Terrestrial; narrow, linear, forming dichotomously divided bands:—*N. flagelliforme* Berk.

Diatoms of Thames Mud.*—Dr. F. Bossey has investigated the fresh- and salt-water diatoms found in mud-banks in the Thames, for the purpose of showing the influence of the flood and ebb tides on their formation, and gives the details of the result in an elaborate table.

Mud taken from seven different localities showed the following proportions of fresh-water and salt forms:—

	Fresh water.	Salt.
Half a mile above Teddington Lock	66	0
One mile below Teddington Lock ..	54	0
Kew	52	37
Blackwall	39	45
Estuary of the Thames	9	60

Dr. Bossey considers that in face of these facts the study of the natural history of the Thames mud affords important evidence in support of the position taken up by the Conservators of the Thames, that the mud-banks forming in the river owe their origin to the discharge of matters from the outlets of the main-drainage system.

* Proc. Holmesdale Nat. Hist. Club, 2 pp. and a table.

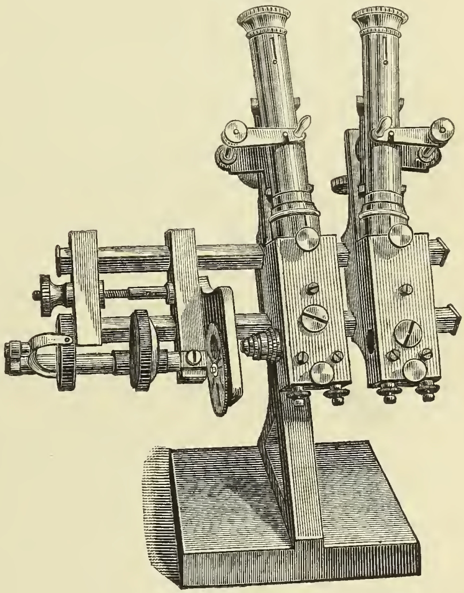
MICROSCOPY.

a. Instruments, Accessories, &c.*

Goltzsch's Binocular Microscope.†—We give the description of this Microscope, translated from the author's German original, with slight modifications only.

"This Microscope (Fig. 3), which is simple to the highest imaginable degree, is calculated to obviate a number of theoretical and practical objections which may be raised against instruments of the same kind hitherto described. In particular we get rid of—

Fig. 3.



(1) All difficulty in combining the images and all strain to the eyes.

(2) All variation in magnitude and distinctness, as also in the adjustment of the images.

(3) All difficulty in accommodating the instrument for different widths between the eyes.

(4) The influence which the thickness of the glass prisms, analogous to the known influence of the thickness of the covering glass, might exert on the course of the rays.

And lastly, instead of the double reflection, which is not avoided in any of the instruments known, there is only a single reflection for each half of the rays.‡

All these advantages are obtained by a slight modification in the manner in which the images are produced. Whilst in the case of the compound Microscope the object must always be a little beyond the focal point, and in the simple Microscope is generally nearer, in the new arrangement it is brought to the focus itself, so that the pencils of rays proceeding from the different points of the object,

* In this section are also included optical notes, notices of books relating to the Microscope, and miscellaneous microscopical notes.

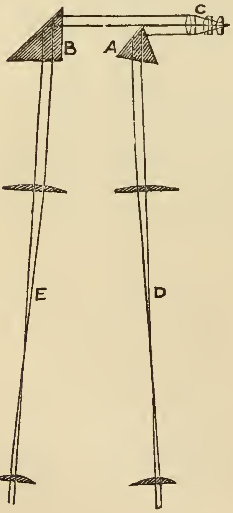
† Carl's Repert. f. Exper.-Physik, 1879, pp. 653–6 (1 fig.). Zeitschr. f. Mikr., ii. (1879) p. 166–9.

‡ The author appears not to have seen the Stephenson binocular.

although their inclination to the axis is different, leave the objective as pencils of parallel rays, and therefore of themselves produce no image, or rather one at an infinite distance. The convergence of the pencils of rays requisite to produce a real image is effected afterwards by means of the eye-pieces, which consequently it would be more correct to regard as telescopes, though they consist, like ordinary microscopical eye-pieces, only of two plano-convex lenses of crown glass, the ratio between their focal lengths being about 1 : 3. It will be seen at once that, by employing this telescopic eye-piece to receive the pencils of rays emerging parallel from the objective and coming as it were from an infinite distance, it is not necessary that Microscopes thus constructed should be of a fixed length. The length may be altered at will without producing any change in the amplification and distinctness of the image after it has been once obtained, provided the telescopic eye-piece is so adjusted, by means of a draw-tube arrangement, that distant objects can be clearly seen by it. It is equally obvious how, by this process, the exact parallelism of the pencils of rays emerging from the objective, and consequently the position of the object in the focus, is regulated and known. This furnishes us with a basis which renders it possible to obtain such a direction for each half of the pencil of rays by a single reflection that each eye can take in one of the halves.

In the original axis of the Microscope there are placed two glass prisms, a smaller, A, Fig. 4, and a larger one B, which are fixed in such a manner that the smaller prism causes one half of the rays and the larger prism the other half to be diverted from the axis under different angles by total reflection. The two pencils D E of parallel rays, are directed into the eye-pieces through two tubes which converge slightly towards the lower extremity. The original axis of the Microscope lies horizontally, and on the right of the observer is the objective C, the stage, and the illuminating apparatus; the observer looks down from above (in a direction inclined as may be desired) through the two converging tubes, directly upon the horizontal axis and with each eye over one of the two reflecting prisms. The first of these of course projects only as far as the axis, so as to leave half the opening free for the second. They are so arranged on the axis that they, with the eye-pieces to which they are attached, can be moved by rack and pinion so that their distance apart corresponds with the distance between the eyes of the observer, without the image being affected by the difference or alteration in the course traversed by the pencils

Fig. 4.

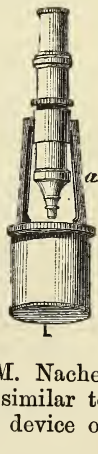


up to the first lens of the eye-piece, their rays being parallel. To this parallelism it is due likewise that every disturbing effect (like that which the thickness of the cover-glass exerts) by the prisms on the transmitted pencil is excluded, for such effects can only be produced by converging or diverging pencils.

The mode of using an instrument so constructed does not differ from that of an ordinary Microscope, except that first the two eye-pieces must be removed and adjusted for infinite distance, and then replaced. By means of the adjusting movement the left eye-piece tube is then put in such a position that with proper illumination the two diaphragm apertures of equal size, which are inside the eye-pieces, are seen without effort as one; an object being now introduced and brought into focus, the plastic image infallibly appears, and cannot be seen double. To produce this effect in perfection, however, the position of the prisms must be so adjusted that the images together with the diaphragm apertures become merged into one complete whole, and the impression is produced of looking through a round opening at the object which is behind. After this position of the prisms has been once fixed no focussing that may be necessary alters the effect. The figure shows that the half of the rays which pass to the second prism is that furthest from the observer; in the opposite case the effect would be pseudoscopic.

Plane mirrors of glass may be used instead of the prisms, but the surfaces of both the prisms and the mirrors must of course be perfect. The prism which is inserted half-way, A, is best made equilateral, because with a rectangular one the total reflection might be questionable, and the edge is better; the other may be rectangular, and should be of such a size that when the first is removed it can take in and reflect the full pencil of rays; we then have a monocular Microscope. It is obvious that instead of the eye-pieces described, actual achromatic telescopes could be used."

Fig. 5.



Hartnack's Demonstration Microscope.* — This (Fig. 5) consists of a tube, carrying eye-piece and objective, fixed to a frame by which it can be held in the hand. A micrometer screw *a* serves for focussing the object which is fixed to the circular stage by clamps. The continuation of the stage forms a metallic drum, at the lower end of which is a convex lens L to concentrate light on the object. A diaphragm-disk is inserted in the drum with a portion of its margin projecting on one side so as to be revolved by the finger.

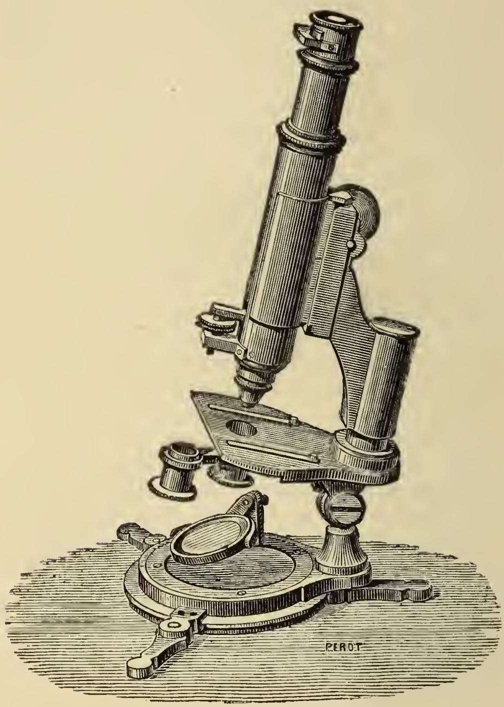
Lacaze-Duthiers' Microscope with Rotating Foot.—M. Nachet has supplied us with a drawing (Fig. 6) of a Microscope similar to that which we described at p. 873 of Vol. III. It is the device of Professor H. de Lacaze-Duthiers.

The speciality of the instrument is that the bottom of the pillar

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, p. 55 (1 fig.).

is attached to a movable ring so that the rotation is on the base and not on the stage (as in the larger Nachet models), the mirror remaining fixed.

Fig. 6.



The special object of the design is stated to have been to reduce the height of the instrument as much as possible, the method adopted for the rotation "allowing the stage to be less elevated above the table and thinner."

Nachet's Portable Microscope.—This Microscope is shown in Figs. 7 and 8 set up for use as a table Microscope. Fig. 8 is intended to show its application to the observation and dissection of large surfaces or objects contained in small troughs or tubs. By loosening the milled ring just above the stage (A, Fig. 8, C, Fig. 9) the compound body can be removed, and an arm L carrying a lens or doublet substituted. To put the instrument in its box (Fig. 11), the stage P (Fig. 10) is turned completely over on the pivot O, and the base is then only 4·5 cm. in height. The box is 19 cm. × 11 cm. × 6 cm.

The instrument seems to be an excellent solution of the problem of constructing a Microscope which shall be really "portable" and at the same time quite steady for ordinary use.

Fig. 7.

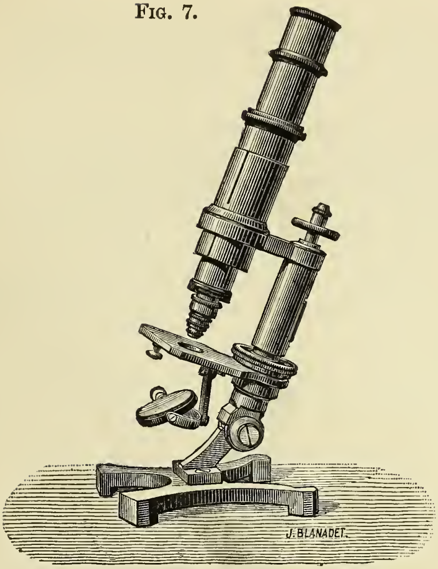


Fig. 8.

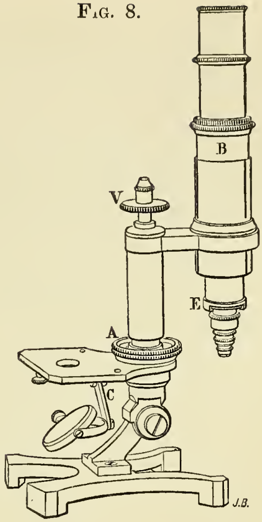


Fig. 9.

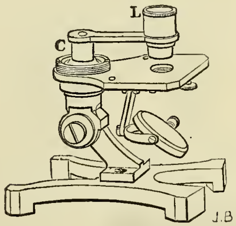


Fig. 10.

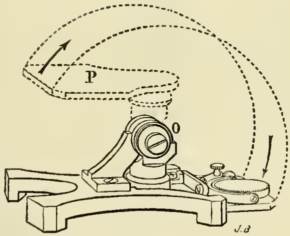
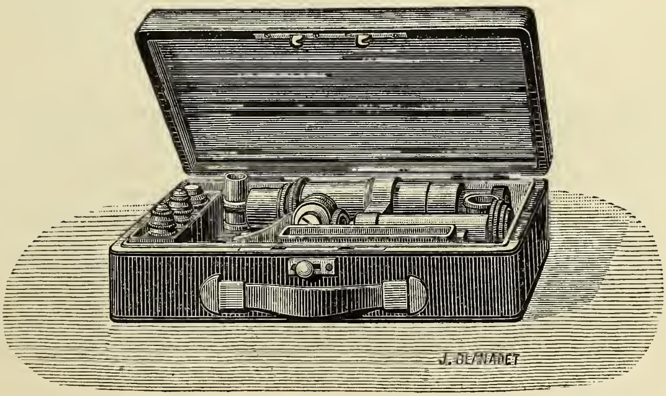


Fig. 11.



Parkes's "Drawing-room" Microscope.—The peculiarity of this Microscope (apart from its title and golden colour) consists in the revival of the "magnetic bar adjustment" to the stage, a device originated by Mr. G. Busk.

Piffard's Skin Microscope.—Dr. Stowell recalls * the Microscope for the examination of the skin, devised by Dr. H. G. Piffard,† to obviate the inconveniences attendant upon a simple lens of high power, which "often involves a constrained position of the head and neck, and in some cases an unpleasant proximity to the subject under investigation."

Dr. Piffard's description is as follows:—"A (Fig. 12) represents the body of a binocular Microscope made by Nachet, from which the

Fig. 12.

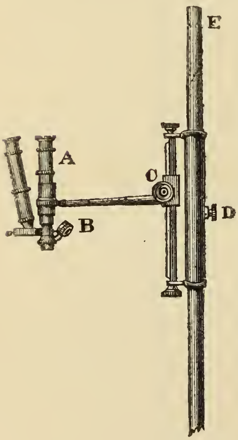
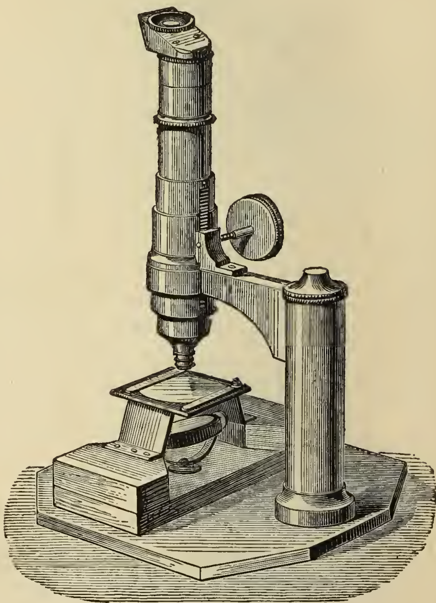


Fig. 13.



reflecting prism situated above the objective was removed, and another of the same focus but double the size substituted. B is a double nose-piece carrying two objectives of different powers. C is the pinion for fine adjustment (raising and lowering the horizontal arm); and D the clamping screw for coarse adjustment, the whole apparatus sliding up and down the rod. E is a rod, five feet in length, which supports the other apparatus, and is itself supported by a cast-iron foot not shown in

* 'The Microscope,' i. (1881) pp. 33–8. (1 fig.).

† 'An Elementary Treatise on Diseases of the Skin, for the use of Students and Practitioners.' (8vo, London and New York, 1876.) See pp. 32–41. (1 fig.)

the drawing. Other adjustments permit the body of the Microscope to be placed in a horizontal or any other desired position. . . . With the instrument described, any portion of the integument, from the scalp to the sole of the feet, can be conveniently examined, and a prolonged examination can be made without fatigue to the observer. It is an instrument which I cannot too highly recommend to those desiring a thorough knowledge of the surface aspect of the skin and its lesions."

Robin's Dissecting Microscope.—This (made by MM. Nachet) is shown in Fig. 13, with their erecting eye-piece. The stage is arranged so as to provide rests for the hands on either side of the dissecting plate.

Brücke Lens.—A description of this lens (Fig. 14), much in use on the Continent, does not appear in any of the English books on the Microscope. We take the following from M. Robin's treatise.*

"To remedy the inconvenience of the lens being too close to the object in all but low powers, Charles Chevalier in his 'Manuel du

FIG. 14.

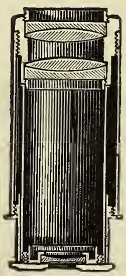
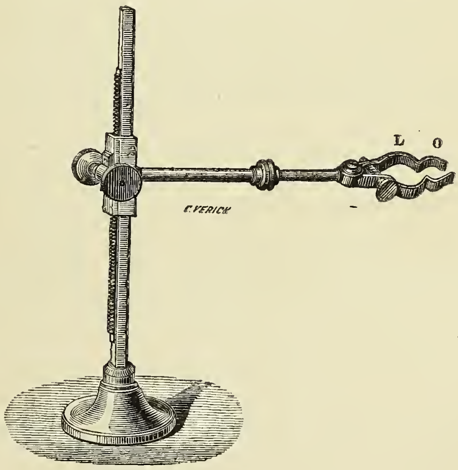


FIG. 15.



Micrographe' (1839) proposed 'to place above a doublet a concave achromatic lens, the distance of which could be varied at pleasure. The effect of this combination is to increase the magnifying power and lengthen the focus. Thus arranged, this instrument will be the most powerful of all simple Microscopes, and the space available for scalpels, needles, &c., will be much greater than with a doublet alone. The further the concave lens is removed from the latter, the greater will be the amplification.' This combination, applied to lenses for examining the eye and skin, allows the use of doublets which leave

* Robin, C., 'Traité du Microscope et des Injections,' 2nd ed. (8vo, Paris, 1877), pp. 33–4 (1 fig.).

a considerable distance above the object, and it is this idea which has governed the construction of the Brücke lens.

"The lens has a very long focus, and the construction is that of the Galileo telescope as applied to opera-glasses, but the amplification of the objective is much greater than that usually obtained in opera-glasses. The focus is about 6 cm., and the power three to eight times. The latter power is obtained by lengthening the tube, by which means the distance between the two lenses is much enlarged and the amplification increased without inconveniently modifying the focus.

"This lens may be used in place of the body of a compound Microscope when it is desired to dissect or to find small objects, or it can be adapted to a simple Microscope or lens-holder with from 3 to 8 cm. between the object and objective."

Künckel d'Herculais devised a holder for the lens shown in Fig. 15. By tightening the screw on the horizontal arm the "jaws" are separated or closed. The arm can be lengthened if desired and also raised or lowered by the rack and pinion. L is the place for the lens and O for doublets.

The Model Stand.*—Mr. J. D. Cox discusses the changes that have taken place in microscope-stands with a view of determining which will be of permanent value and should form part of the features of a complete stand, and thus summarizes the essential requisites which ought to be embodied in every instrument intended for real scientific use.

1. A firm and rigid *arm* having the general character of the Jackson model, carrying the body of the instrument, with coarse and fine adjustments conveniently placed below the body, with perfectly even and reliable motion.

2. A firm ring as the basis of the *stage*, to which any form of stage-plate, plain with clips, glass, or mechanical, may be adapted and interchanged. Nearly every microscopist has work to do for which a mechanical stage is almost indispensable, such as micrometric measurements, and the systematic sweeping of a slide to make sure that every part has been examined. There should be no rack and pinion movement for revolving the stage as it can be better done with the fingers, nor a centering adjustment unless the instrument is intended for goniometry. The stage thin enough to allow the use of light of at least 70° obliquity from the axis of the instrument.

In regard to the requisite of reversibility for the stage, Mr. Cox points out that in nearly every department of natural science (and not for diatoms only) there is need of the occasional use of light of extreme obliquity upon dry mounts and from the mirror alone, so that an easily reversible stage is desirable. If, however, immersion illuminators came to be used for dry mounts as well as those in balsam † a reversible stage would not be necessary, as a ray incident at 41° only would emerge at the maximum obliquity of 90°.

3. A grooved bar—immovable and not swinging—for the support

* Amer. Jour. Micr., vi. (1881) pp. 89–95 (4 figs.).

† This should read "for dry *objectives* as well as immersion." Balsam mounts are on the same footing as dry mounts *when a dry objective is used.*

of the *substage* with centering screws and which may or may not be fitted with rack and pinion movement. No illuminating apparatus to be attached to the bottom of the stage proper. The diaphragm with tapering nose so that it can be racked up close to the bottom of the slide.

4. The *mirror-bar* to swing on the optical centre of the instrument above as well as below the stage, and to have a sliding extension so as to increase the distance between the mirror and the stage without changing the angle of the incident light.

5. Such form of *base* as will permit the mirror to be swung laterally when the instrument is in upright position.

Mr. Cox objects to the substage and mirror-bar swinging together, on the ground that it is then necessary to attach "the immersion illuminators to the bottom of the stage by some special means, such as bayonet catch, screw in the stage-well, &c.," and he advises that all such apparatus should be used in the substage for which it was in fact devised. He suggests and figures an attachment to carry an immersion illuminator, consisting of a movable elbow-piece on a slotted arm sliding on a pin that screws on the outer end of a short right-angled dove-tail slide fitting into a corresponding bar cast on the substage carrier that racks or slides on the fixed tail-piece. This appears to us, however, a complicated way of applying a simple immersion illuminator such as the hemispherical lens, and we cannot see any objection to mounting the lens in a disk to fit into the stage-well or the under surface of the rotating stage plate.

For use with the Continental stands that are not provided with mechanical stages, Mr. Zeiss mounts the lens in a disk of brass which drops into the bevelled central stage opening, the plane face is then flush with the surface of the stage.

Denomination of Eye-pieces and Standard Gauges for same.—The Committee appointed by the Council in October last to consider the question of standard gauges for eye-pieces (and substages) duly presented their report, which was thereupon ordered to be printed and circulated amongst the members of the Council, and is now under consideration.

Subsequently to the report being made, the following circular was received by some of the English opticians from a committee of the American Society of Microscopists, unfortunately too late to be laid before the Committee.

"1*st Question.*—Please give list of various eye-pieces or oculars for the Microscope made by you, with construction (Huyghenian, orthoscopic, periscopic, &c., &c.), with the equivalent amplifying power of each, at a standard distance of 10 English inches or 254 mm.

2. Please state how you determine the amplifying power of your eye-pieces.

3. Do you consider it desirable that a uniform nomenclature (with reference to amplifying power) of eye-pieces should be adopted by makers of Microscopes?

4. Will you adopt such a nomenclature if decided upon by this Society?

5. Please suggest such a nomenclature which seems to you most generally applicable and desirable.

6. Do you consider it desirable that eye-pieces should be so constructed—by means of a shoulder or other device on the longer ones—that all should pass the same distance into the tube of the Microscope, thereby preserving the blackening of the inside of the microscope-tube?

7. Please give inside diameter of microscope-tube, or draw-tube where there is one, or outside diameter of that portion of eye-piece fitting into the microscope-tube for each size of stand made by you.

8. Do you consider it desirable that two, or three, or more *standard diameters* of tube for Microscopes be generally adopted with a view to interchangeability of eye-pieces?

9. Please suggest the number of sizes and the inside diameter of tube in each case, which you would recommend for adoption.

10. Will you adopt a standard set of sizes if agreed upon and recommended by this Society?

11. Please give this committee the benefit of any suggestions not included in the above answers."

The inquiry of the American committee embraces a wider field than that of the Society's committee, which was limited to the question of standard gauges for eye-pieces and substages, and does not include a consideration of the proper denomination for eye-pieces, though the present system of nomenclature is an even greater evil than that of the numerous different sizes.

Every one feels the inconvenience of the Continental method of numbering or lettering *objectives*, a special table being necessary to enable the relative powers of Monsieur A's No. 2, and Herr B's No. 3 to be compared; the English plan of denoting the objective by inches and fractions of an inch is obviously preferable.

Having adopted this improvement, however, and even being accustomed to wonder how our Continental brethren can still tolerate so barbarous a system of marking objectives, it is remarkable that the designation of eye-pieces should have been allowed to remain on the principle abandoned for objectives, and that the letters A, B, C, D, &c., by which they are known, should still express absolutely nothing as to their magnifying power, beyond the fact that D is to some undefined extent more powerful than C, C than B, and B than A; so that not only is it impossible to compare the eye-pieces of different makers, but it is not possible to do so in the case of the same maker, unless the powers are actually known.

If eye-pieces were, however, denoted on the same principle as objectives, nothing whatever would be lost, and much would be gained.

For instance, if the magnifying power of a $\frac{1}{5}$-inch objective with a C eye-piece is required, it will be 500 or 750, according as the eye-piece is that of one or the other maker. If, however, instead of being labelled C (or No. 3), the eye-pieces were called $\frac{2}{3}$-inch or 1-inch, the necessary calculation ($50 \times 15 = 750$ or $50 \times 10 = 500$) is instantly made.

TABLE OF MAGNIFYING POWERS.

OBJECTIVES.		EYE-PIECES.								
		Beck's 1, Powell's 1, Ross's A.	Beck's 2, Powell's 2 and Ross's B, nearly.*	Powell's 3	Ross's C.	Beck's 3.	Beck's 4, Powell's 4. Ross's D.	Beck's 5. Ross's E.	Powell's 5.	Ross's F.
		FOCAL LENGTH.								
		2 in.	$1\frac{1}{3}$ in.	1 in.	$\frac{4}{5}$ in.	$\frac{2}{3}$ in.	$\frac{1}{2}$ in.	$\frac{4}{10}$ in.	$\frac{1}{3}$ in.	$\frac{1}{4}$ in.
		MAGNIFYING POWER.								
FOCAL LENGTH.	MAGNIFYING POWER.	5	$7\frac{1}{2}$	10	$12\frac{1}{2}$	15	20	25	30	40
		COMBINED AMPLIFICATION OF OBJECTIVES AND EYE-PIECES.								
in.										
5	2	10	15	20	25	30	40	50	60	80
4	$2\frac{1}{2}$	$12\frac{1}{2}$	$18\frac{3}{4}$	25	$31\frac{1}{4}$	$37\frac{1}{2}$	50	$62\frac{1}{2}$	75	100
3	$3\frac{1}{3}$	$16\frac{2}{3}$	25	$33\frac{1}{3}$	$41\frac{2}{3}$	50	$66\frac{2}{3}$	$83\frac{1}{3}$	100	$133\frac{1}{3}$
2	5	25	$37\frac{1}{2}$	50	$62\frac{1}{2}$	75	100	125	150	200
$1\frac{1}{2}$	$6\frac{2}{3}$	$33\frac{1}{3}$	50	$66\frac{2}{3}$	$83\frac{1}{3}$	100	$133\frac{1}{3}$	$166\frac{2}{3}$	200	$266\frac{2}{3}$
1	10	50	75	100	125	150	200	250	300	400
$\frac{8}{10}$	$12\frac{1}{2}$	$62\frac{1}{2}$	$93\frac{3}{4}$	125	$156\frac{1}{4}$	$187\frac{1}{2}$	250	$312\frac{1}{2}$	375	500
$\frac{3}{4}$	$13\frac{1}{3}$	$66\frac{2}{3}$	100	$133\frac{1}{3}$	$166\frac{2}{3}$	200	$266\frac{2}{3}$	$333\frac{1}{3}$	400	$533\frac{1}{3}$
$\frac{2}{3}$	15	75	$112\frac{1}{2}$	150	$187\frac{1}{2}$	225	300	375	450	600
$\frac{1}{2}$	20	100	150	200	250	300	400	500	600	800
$\frac{4}{10}$	25	125	$187\frac{1}{2}$	250	$312\frac{1}{2}$	375	500	625	750	1000
$\frac{1}{3}$	30	150	225	300	375	450	600	750	900	1200
$\frac{3}{10}$	$33\frac{1}{3}$	$166\frac{2}{3}$	250	$333\frac{1}{3}$	$416\frac{2}{3}$	500	$666\frac{2}{3}$	$833\frac{1}{3}$	1000	$1333\frac{1}{3}$
$\frac{1}{4}$	40	200	300	400	500	600	800	1000	1200	1600
$\frac{1}{5}$	50	250	375	500	625	750	1000	1250	1500	2000
$\frac{1}{6}$	60	300	450	600	750	900	1200	1500	1800	2400
$\frac{1}{7}$	70	350	525	700	875	1050	1400	1750	2100	2800
$\frac{1}{8}$	80	400	600	800	1000	1200	1600	2000	2400	3200
$\frac{1}{9}$	90	450	675	900	1125	1350	1800	2250	2700	3600
$\frac{1}{10}$	100	500	750	1000	1250	1500	2000	2500	3000	4000
$\frac{1}{11}$	110	550	825	1100	1375	1650	2200	2750	3300	4400
$\frac{1}{12}$	120	600	900	1200	1500	1800	2400	3000	3600	4800
$\frac{1}{13}$	130	650	975	1300	1625	1950	2600	3250	3900	5200
$\frac{1}{14}$	140	700	1050	1400	1750	2100	2800	3500	4200	5600
$\frac{1}{15}$	150	750	1125	1500	1875	2250	3000	3750	4500	6000
$\frac{1}{16}$	160	800	1200	1600	2000	2400	3200	4000	4800	6400
$\frac{1}{17}$	170	850	1275	1700	2125	2550	3400	4250	5100	6800
$\frac{1}{18}$	180	900	1350	1800	2250	2700	3600	4500	5400	7200
$\frac{1}{19}$	190	950	1425	1900	2375	2850	3800	4750	5700	7600
$\frac{1}{20}$	200	1000	1500	2000	2500	3000	4000	5000	6000	8000
$\frac{1}{25}$	250	1250	1875	2500	3125	3750	5000	6250	7500	10000
$\frac{1}{30}$	300	1500	2250	3000	3750	4500	6000	7500	9000	12000
$\frac{1}{40}$	400	2000	3000	4000	5000	6000	8000	10000	12000	16000
$\frac{1}{50}$	500	2500	3750	5000	6250	7500	10000	12500	15000	20000
$\frac{1}{60}$	600	3000	4500	6000	7500	9000	12000	15000	18000	24000
$\frac{1}{80}$	800	4000	6000	8000	10000	12000	16000	20000	24000	32000

* Powell and Lealand's No. 2 = 7·4, and Beck's No. 2 and Ross's B = 8 magnifying power or respectively $\frac{1}{75}$ less and $\frac{1}{15}$ more than the figures given in this column.

Judging from past experience, it will probably be too much to expect that the desired change should take place all at once, and that the A, B, C, &c., or Nos. 1, 2, 3, &c., should forthwith be swept away, but we would venture to suggest that the power of the eye-piece should be indicated in the catalogues and elsewhere, as well as the old title, and if this were done we are sure that the latter would soon be wholly disused.

The tables of magnifying powers issued by opticians are at present, in many cases, of a very misleading character, not so much from the fact that the objectives are underrated—a true $\frac{1}{10}$-inch being called a $\frac{1}{8}$-inch—but that, according to the tables, one and the same eye-piece magnifies differently when it is used with different objectives!

We have accordingly compiled the annexed table of magnifying powers for ready reference. It includes all the more usual objectives, and the full series of eye-pieces of Messrs. Beck, Powell, and Ross. It will be noticed that the magnifying powers of the No. 1 or A agree in all three cases, those of the No. 2 or B slightly varying, being 8, 7·4, and 8. It would be an improvement if they could all be made $7\frac{1}{2}$, which would preserve the uniformity of the series. The No. 3 or C vary greatly, being 15, 10, and $12\frac{1}{2}$. The No. 4 or D agree, whilst No. 5 or E are 25, 30, and 25.

We think that an ideal series should run thus:—No. 1 = 5, No. 2 = $7\frac{1}{2}$, No. 3 = $12\frac{1}{2}$, No. 4 = 20, No. 5 = 30.

With the exception of the $\frac{1}{13}$, $\frac{1}{17}$, and $\frac{1}{19}$, all the objectives included in the table are actually constructed by English or foreign opticians. As objectives are, however, not uncommonly found to vary somewhat from the designated focal lengths, the figures for the $\frac{1}{13}$, $\frac{1}{17}$, and $\frac{1}{19}$ have been retained.

The length of tube is assumed as usual to be 10 inches.

Braham's Microgoniometer.*—At a recent meeting of the Bath Microscopical Society, Mr. Braham described a microgoniometer for measuring the angles of crystals. "The body of the microscope-tube is formed at right angles. A rectangular prism is so adjusted that the plane of the hypothenuse is at an angle of 45 degrees to the axis of rotation. On bringing any crystal into the centre of the field, a fibre in the focus of the eye-piece is made to coincide with either of its edges so that the degrees passed through can easily be read. Thus, as the instrument measures a magnified image of the crystal, and the object itself is stationary, it will readily be seen that the angles of any crystal visible under the highest powers of the Microscope can easily be measured."

Watson's Sliding-box Nose-piece.—Messrs. Watson have recently contrived a sliding-box nose-piece to carry (1) the vertical illuminator (Fig. 16), or (2) the analyzing prism (Fig. 17) of the polarizing apparatus, or (3) the binocular prism. The application of an extra nose-piece in this form appears to be convenient. Experience must,

* Engl. Mech., xxxiv. (1881) p. 277.

however, decide how far it is advisable to add to Microscopes focussing at the nose-piece, extra appliances tending to affect the delicate fitting of the fine adjustment.

FIG. 16.

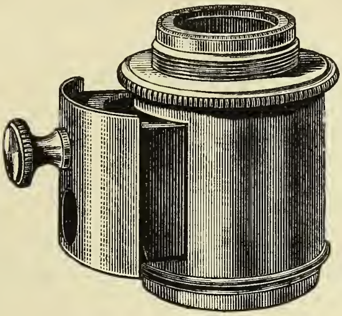
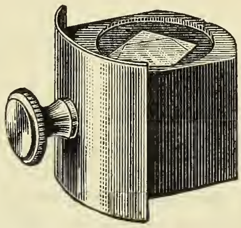
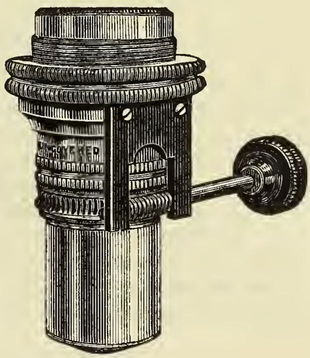


FIG. 17.



Deby's Screw-Collar Adjustment.—Mr. J. Deby suggests that the application of a worm-wheel and tangent screw to the screw-collar adjustment of objectives (Fig. 18) would be found more convenient than the usual system for adjusting the corrections with accuracy. The device, as figured, would not permit the objective to be enclosed in the ordinary brass box; but, as suggested by Mr. Beck, the tangent pinion might be cut off short and provided with a slightly tapering square head upon which the milled head would fit when required.

FIG. 18.



Number of Lenses required in Achromatic Objectives. * —Mr. W. Harkness discusses the number of lenses required in an achromatic objective consisting of infinitely thin lenses in contact, in order that with any given law of dispersion whatever, the greatest possible number of light-rays of different degrees of refrangibility may be brought to a common focus.

For any system of thin lenses in contact we have

$$\frac{1}{f} = (\mu_1 - 1)\,A_1 + (\mu_2 - 1)\,A_2 + (\mu_3 - 1)\,A_3 + \text{etc.}, \qquad (1)$$

the number of terms being unlimited. For a dispersion formula we write

$$\mu = \phi\,(\lambda) \qquad (2)$$

The form of $\phi\,(\lambda)$ is unknown, but there will be no loss of gene-

* Bull. Phil. Soc. Washington, iii. (1878–80) pp. 65–7. Smithsonian Misc. Collections, xx. (1881).

rality if it is developed in a series arranged according to the powers of λ. We, therefore, have

$$\mu = a + b\,\lambda^m + c\,\lambda^n + e\,\lambda^p + \text{etc.,} \qquad (3)$$

in which a, b, c, etc., are constants, and the number of terms may be taken as great as is desired.

Let us also put

$$\begin{aligned} C &= A_1(a_1 - 1) + A_2(a_2 - 1) + A_3(a_3 - 1) + \text{etc.} \\ D &= A_1 b_1 + A_2 b_2 + A_3 b_3 + \text{etc.} \\ E &= A_1 c_1 + A_2 c_2 + A_3 c_3 + \text{etc.} \\ F &= A_1 e_1 + A_2 e_2 + A_3 e_3 + \text{etc.} \\ &\quad \text{etc.} \qquad \text{etc.} \qquad \text{etc.} \end{aligned} \qquad (4)$$

the number of these equations, and the number of terms in the right-hand member of each of them, being the same as the number of terms in the right-hand member of (3). Now substituting for the μ's in (1) their values in terms of the auxiliaries C, D, E, etc., of the equations (4), we find

$$\frac{1}{f} = C + D\,\lambda^m + E\,\lambda^n + F\,\lambda^p + \text{etc.} \qquad (5)$$

Considering λ as the abscissa, and f as the ordinate, this is the equation of the focal curve. Its first derivative, with respect to f and λ, is

$$\frac{df}{d\lambda} = -f^2(m\,D\,\lambda^{m-1} + n\,E\,\lambda^{n-1} + \text{etc.}), \qquad (6)$$

which, as is well known, expresses for every point of the curve the tangent of the angle made by the tangent line with the axis of abscissas. The number of rays of different degrees of refrangibility which can be brought to a common focus will evidently be the same as the number of times that the focal curve intersects the focal plane. But the focal plane is necessarily parallel to the axis of abscissas; and therefore the greatest possible number of intersections of the curve with the plane can only exceed by one the number of tangents which can be drawn parallel to the axis of abscissas. To find these tangents we equate (6) to zero, and obtain

$$0 = m\,D\,\lambda^{m-1} + n\,E\,\lambda^{n-1} + \text{etc.} \qquad (7)$$

As λ can never be either zero, negative, or imaginary, we have to consider only the real positive roots of this equation; each of which corresponds to a tangent. To make the number of tangents as great as possible, the quantities D, E, F, etc., must be independent of each other; which will be the case when the right-hand members of the equations (4) contain as many A's as there are powers of λ in the dispersion formula (4). All the terms of (7) contain the common factor λ^{m-1}. Taking it out we have

$$-m\,D = n\,E\,\lambda^{n-m} + p\,F\,\lambda^{p-m} + \text{etc.,} \qquad (8)$$

from which it is evident that the number of real positive roots in (7) will always be one less than the number of powers of λ in (3). Hence we conclude that:—

In any system of infinitely thin lenses in contact, the number of lenses required to bring the greatest possible number of light-rays of different degrees of refrangibility to a common focus is the same as the number of different powers of λ contained in the dispersion formula employed.

The method made use of in arriving at this result has been adopted, because it brings out clearly the geometrical relations of the problem. The result itself is evident from a mere inspection of equation (5), which cannot possess more real positive roots than it has independent auxiliaries, D, E, F, etc.

Colour Corrections of Achromatic Objectives.*—The following abstract is published of a paper by W. Harkness:—

1. From any three pieces of glass suitable for making a corrected objective, but not fulfilling the conditions necessary for the complete destruction of the secondary spectrum, it will always be possible to select two pieces from which a double objective can be made that will be superior to any triple objective made from all three of the pieces.

2. The colour correction of any objective is completely defined by stating the wave-length of the light for which it gives the minimum focal distance.

3. An objective is properly corrected for any given purpose when its minimum focal distance corresponds to rays of the wave-length which is most efficient for that purpose. For example: in an objective corrected for visual purposes, the rays which seem brightest to the human eye should have the minimum focal-distance; while in an objective intended for photographic work the rays which produce the greatest effect upon silver bromo-iodide should have the minimum focal-distance.

4. In the case of a double achromatic, the secondary spectrum (or in other words, the diameter, at its intersection with the focal plane, of the cone of rays having the maximum focal length) is absolutely independent both of the focal length of the combination, and of the curves of its lenses; and depends solely upon the aperture of the combination, and the physical properties of the materials composing it.

5. When the focal curve of an objective is known, and the relative intensity, for the purpose for which the objective is corrected, of light of every wave-length is also known; then the exact position which the focal plane should occupy can be readily calculated.

Incidentally, it may be remarked that in an objective corrected for photographic purposes the interval between the maximum and minimum focal distance is less than in one corrected for visual purposes. Hence a photographic objective has less secondary spectrum, and is better adapted for spectroscopic work, than a visual objective.

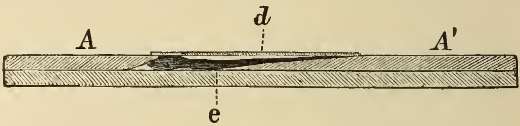
Verification of Objectives.—The editor of the 'Northern Microscopist' undertakes, for a nominal fee of 1*s.* 6*d.*, to verify

* Bull. Phil. Soc. Washington, iii. (1878–80) pp. 39–40. Smithsonian Misc. Coll., xx. (1881).

objectives sent to him in regard to their amplifying power, working distance, absolute size of field, and real aperture.*

Schultze's Tadpole - Slide.† — This slide (or "microscopic aquarium") (Fig. 19) was devised for showing the circulation of the blood or the development of the blood-vessels in the larvæ of the frog and triton. To one side of a thick slide is fastened by means of

Fig. 19.

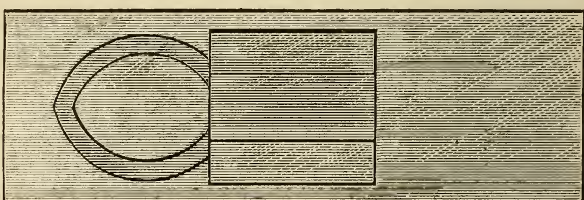


Canada balsam a piece of another slide, cut as represented at A, and to the other side a second piece, of the shape seen at A′, so that there is a small cell in the centre of the slide, of the form shown in section in the figure. A cover-glass *d* closes the cell.

To place the larva *e* in the cell, the cover-glass is taken off and the larva fished out of the water in a small watch-glass, and poured with the water into the cell. By manipulating with a brush, its head is brought into the hollow of the glass at A, and the tail placed on the sloping surface at A′. The cover is then quickly replaced, care being taken that the cell is full of water. The animal is excluded from air by the water, which, when it evaporates, can be replaced with the brush. In this way the circulation of the blood in the tail may be observed for hours at a time.

Stokes' Tadpole-Slide.‡—Mr. A. W. Stokes fastens two pieces of a vulcanite ring (Fig. 20) to an ordinary slide so as to form an oval cell just large enough for the body of the tadpole, the tail projecting through an opening in the cell. Close to the latter a square of thin

Fig. 20.



cover-glass is cemented by Canada balsam so as to raise the tail to a level with the body. On each side of this are cemented two small oblong pieces of thin glass forming a cell for the tail to lie in. A square of cover-glass over the body, and another over the tail, will keep the tadpole in place.

* North. Microscopist, i. (1881) pp. 253–7.
† Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 148–9 (1 fig.).
‡ Ann. Rep. Postal Micr. Soc., 1881, p. 13 (1 fig.).

"Swinging Substage," or "Swinging Tail-piece."—At the time this contrivance was first introduced it was known as a "Swinging Tail-piece," but since that time the term "substage" has been almost universally substituted. The earlier name is obviously, however, the more appropriate, as it is not simply the substage which swings, but the mirror also, and we intend to adopt in future the expression "swinging tail-piece."

Value of Swinging Tail-pieces.—In addition to the opinions cited at p. 666 of Vol. I. (1881), the following has been published during the past year:—

Mr. J. D. Cox, in the paper above referred to (see p. 102), considers that the swinging of the mirror-bar on the optical centre of the instrument is a positive improvement, but that the swinging of the substage is of very doubtful value. "In the former case several real advantages are gained. First, the mirror is kept at its proper focal distance from the object. Second, it may be swung above the stage for illumination of opaque objects. Third, it allows the instrument to be used for measuring aperture of object-glasses, by converting it into Smith's 'Universal Apertometer.'* But when we ask for the advantages of swinging the substage with illuminating apparatus, it is difficult to find them. It is plain that we don't want to swing the polariscope, the parabola, the dark wells, the Webster condenser, the wide-angled achromatic condenser, or the immersion illuminators, and could not if we would, for the form and mounting of these accessories is inconsistent with doing so. The question must practically be narrowed to the desirability of swinging the diaphragm and the low-angled achromatic condenser. Of course none of the flat diaphragms can be swung in this manner, and no advantage seems to be found in the use of the sharp-nosed diaphragms with oblique light. The fact is that there are advantages in taking oblique light directly from the mirror; for the chromatic fringes at the margin of the illumination often enable the microscopist to modify the light in a way to get increased resolution by turning the mirror so as to take the most lateral rays and those nearest the blue end of the spectrum. More range in quality of illumination can be got by the practised hand in this way than by the oblique use of the diaphragm.

"In the use of an achromatic condenser, it must be a very low angle indeed which will work far enough from the bottom of the stage to allow much swinging to right or left, especially when we take into account the fact that the centering of the substage becomes more important when it is swung away from the axis of the instrument.

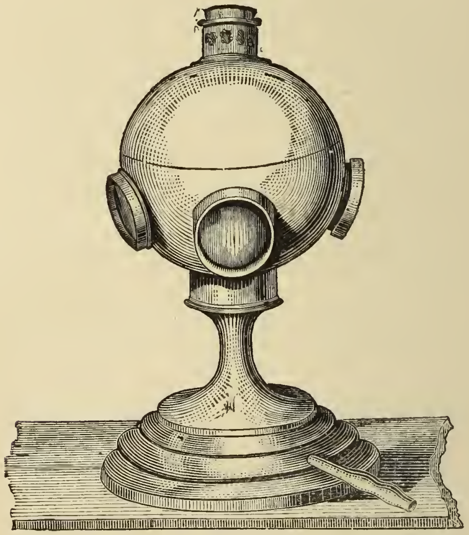
"The centering arrangement of the substage will occupy so much lateral room that it can be swung but a little way before striking the stage. Again, any achromatic condenser of even moderate angle can be swung very little to right or left before its marginal rays will become parallel to the bottom of the slide containing the object under examination, and they then, of course, cease

* See this Journal, ii. (1879) p. 775.

to penetrate to the object or be of use for illumination. Still, again, experience seems to prove very conclusively that the most effective as well as the simplest arrangement for securing oblique light (otherwise than from the mirror alone) is by the prism, the traverse lens, the Wenham 'half button,' or other immersion substage illuminators. These considerations lead strongly to the conclusion that the swinging of the substage is useless."

Ranvier's Microscope-Lamp.*—This (Fig. 21) is described as consisting essentially of a metal globe, which covers the cobalt glass lamp chimney "and prevents the radiation of heat." Four openings with plano-convex lenses conduct the light to four Microscopes. "The light can be so subdued that it is possible to work a long time

FIG. 21.



in the evening without straining the eyes, for which reason the lamp is preferable to all other kinds of illuminating apparatus. The cobalt glass is an essential feature, because the yellow-colour of the lamp-light is thereby obviated, and the sensation of white is produced. Certain shades of yellow and blue, as is well known, stand in relationship to each other as complementary colours, that is they produce white."

Hollow Glass Sphere as a Condenser.†—Mr. F. Kitton describes the effects of using a glass globe filled with water for the purpose of condensing light upon the object. This was used by some of the early microscopists,‡ though it appears soon to have fallen into disuse, as it

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 73–4 (1 fig.).

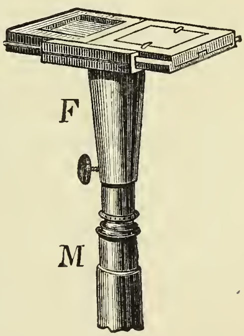
† Sci.-Gossip, 1881, pp. 274–5 (1 fig.).

‡ Hooke, 'Micrographia,' 1665; Ledermüller, 'Mikroskopische Gemüths- und Augen-Ergözung,' 1762.

is not mentioned by Adams in his 'Micrographia Illustrata,' 1771, or in his 'Essays on the Microscope,' 1787. Mr. Kitton tried it first with a $\frac{1}{4}$-inch objective upon *Pleurosigma angulatum*, using oblique light from the mirror; the striæ came out very distinctly. On removing the globe, the striæ vanished and required a more oblique ray to render them again visible. Tried on *Synedra robusta*, it resolved the striæ into beads. With a $\frac{2}{3}$ inch, and not altering the previous position of the mirror, a "black field" was obtained. The object *Haliomma Humboldtii* was seen with beautiful effect, appearing as though illuminated by intense moonlight with a slight green tinge and delightfully cool to the eye. It is also to be recommended with polarized light for softness of tint and impenetrable blackness of field when the prisms are crossed. A globe (6 inches in diameter) should be used, filled with a dilute solution of sulphate of copper (about $\frac{1}{2}$ ounce of saturated solution to 1 pint of water). The mixture must be filtered if ordinary water is used, though the intensity of colour is somewhat a matter of taste. The distance of the globe from the lamp should be about two or three inches; from the globe to the mirror about eight to twelve inches.

Stein's small Microphotographic Apparatus.*—Fig. 22 shows Stein's microphotographic apparatus which, though small and simple, is said to answer its purpose completely. It is on the plan of Harting's apparatus and consists of a cone F which is inserted into the tube M of the Microscope instead of an eye-piece, a plate of ground-glass is fixed to the top, and on this the image can be focussed, the observer's head being covered with a black cloth. The ground-glass plate is replaced by the prepared sensitive plate and the image can then be readily photographed.

Fig. 22.



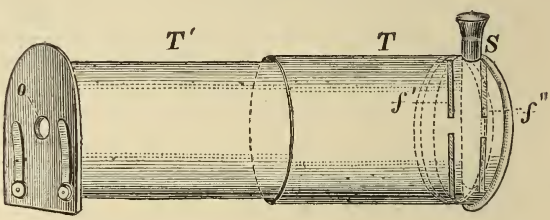
Ranvier's Myo-Spectroscope.†—In this simple and ingenious instrument (available for rapid superficial demonstrations) a prism is replaced by the muscular tissue, the transverse striæ of the muscular bundles acting on white light like a grating and producing spectra.

The muscles of the frog are the most suitable for observation, and especially the sartorius muscle, the bundles of which are parallel. The muscle having been taken with care from a living frog, it is dried for some hours in a stove at 40° C., after having been stretched with pins on a piece of cork. The muscle is then planed on both sides with a sharp scalpel, soaked in turpentine, and mounted in Canada balsam.

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, p. 48 (1 fig.).
† Ranvier's 'Traité technique d'Histologie,' Paris, 1878–80, pp. 316–19 (1 fig.).

The myo-spectroscope is shown in Fig. 23. T′ is a tube 12 cm. long and 4 cm. in diameter, blackened internally, and closed at one end by

Fig. 23.



a diaphragm with a vertical slit f' half a millimetre in breadth. At the other end is a stage plate with a central hole o (5 cm.). The preparation of muscle is placed in the clips in front of the latter hole and so that the axes of the muscular bundles are at right angles to the slit f'. On looking through the hole, whilst the instrument is directed to a light, spectra will be seen on the right or left of the slit.

To observe the absorption-bands of hæmoglobin, a second tube T is added to the instrument, sliding over T′ and having a diaphragm with a large vertical slit f'' in which is placed a tube S containing a solution of blood. Having first seen that the muscle gives a clear spectrum, T with S is replaced and the two absorption-bands of hæmoglobin will be seen in the spectrum.

As the spectrum produced by a grating is more extended according as the lines of the grating are closer together, we are led to investigate whether a muscle at the moment of contraction gives a wider spectrum than when at rest. The lower tendon of the sartorius muscle of a frog is separated from the tibia and the muscle stretched before a slit and it will be seen that on slightly stretching the muscle, the spectrum will be narrow and close to the slit. When the muscle is contracted the converse phenomena are produced, and when it is excited by a current and attains its maximum of contraction the width of the spectra and their distance from the slit are much angmented.

The muscles of different animals thus examined do not give identical spectra. For example, those of the muscles of the frog are broader than those of the white muscles of the rabbit in the ratio of 9 : 7. The transverse striation is therefore finer in the former case than in the latter.

Standard for Micrometry.*—The Philosophical Society of Washington publishes the reply given by Dr. J. J. Woodward to the committee of the Microscopical section of the Troy Scientific Association who asked answers to the following questions:†—

"1. Is it expedient at present to adopt a standard for micrometry?

2. If so, should the English or the metric system be employed?

* Bull. Phil. Soc. Washington, iii. (1878–80) pp. 22–4; Smithsonian Misc. Coll., xx. (1881).

† See this Journal, ii. (1879) pp. 154–5.

3. What unit, within the system selected, is most eligible?

4. What steps should be taken to obtain a suitable standard measure of this unit?

5. How can this standard micrometer be best preserved and made useful to all parties concerned?"

The reply was as follows:—

"1. I am in favour of the adoption of a suitable standard for micrometry by the American Society of Microscopists at their next meeting.

2. For this particular purpose I think the metric system offers so many conveniences that I favour its employment.

3. The selection of an eligible unit within the system involves, it appears to me, two distinct questions: A. How shall the stage-micrometer be ruled? B. How shall the measurements made, be expressed in speech or writing?

A. The object of the stage-micrometer is chiefly to give values to the divisions of the eye-piece micrometer with the power used in any given case. It should be long enough to be used for this purpose with the lowest powers of the compound Microscope, and have a part of its length ruled sufficiently close to answer the same end with the highest powers. I favour the adoption of a standard scale a centimetre long ruled in millimetres, and one of these ruled in hundredths. I have used stage-micrometers ruled in thousandths of a millimetre, but regard such divisions as inconveniently close for this purpose. To measure in thousandths of a millimetre as the unit, which is very convenient in a large number of cases, the simplest way is to use a magnifying power that will make ten divisions of the eye-piece micrometer exactly coincide with one-hundredth of a millimetre on the stage-micrometer. The glass eye-piece micrometer should have a scale a centimetre long ruled in one hundred parts. By increasing the power so that a larger number than ten of these divisions shall correspond to one-hundredth of a millimetre on the stage-micrometer, a unit of any degree of minuteness that may be required for any special work can be obtained up to the limits of distinct vision with the Microscope.

B. But although I regard the hundredth of a millimetre as a very eligible dimension for the closest divisions of the stage-micrometer, when it comes to expressing the results of our measurement in speech or writing, I do not think it is convenient to use the hundredth of a millimetre as the unit of expression. It is too large, and the results of too many measurements would still have to be expressed in decimal fractions. The thousandth of a millimetre is much more convenient as a unit of expression, and I would advise that microscopists should agree to call this dimension a *micron*, and represent it in writing by the Greek letter μ. This dimension has already been adopted as the unit of expression by a number of European microscopists, who represent it by the same Greek letter, but call it a micro-millimetre. The term *micron* should, I think, be preferred because well known to scientific men other than microscopists, having for some time been used in expressing minute differences by those officially engaged in

preparing standard measures of length, and having been adopted by the International Metric Commission. I think it running an unnecessary risk of confusion to select any other than this well-recognized term for the dimension in question.

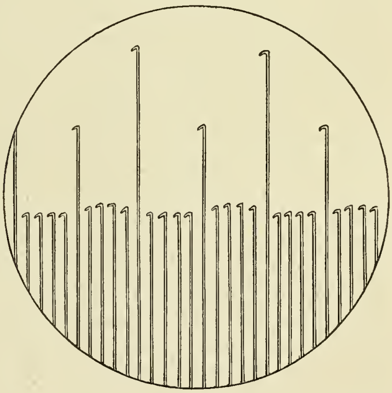
4 & 5. To obtain a suitable standard stage-micrometer, I would advise each microscopical society to select one ruled, as above described, by any person in whom they have confidence, and to satisfy themselves by comparison of the several parts with each other, by means of the same part of the eye-piece micrometer, that the divisions agree among themselves. This is comparatively easily done; the real difficulty will be to determine whether the whole scale is really a centimetre long. To ascertain this, I would advise each microscopical society to send its standard micrometer to the Superintendent of the Coast Survey at Washington, with the request that he will have it compared with a recognized standard in the Bureau of Weights and Measures, and return it with a report of the error, if any. I have reason to believe that such requests would be promptly and courteously responded to. Each society should then preserve the standard thus obtained for the sole purpose of enabling its members to compare their stage-micrometers with it. I think this plan much wiser than to relegate the question to any one of the ingenious men who are endeavouring in this country, with considerable success, to make accurate rulings on glass, and I should anticipate better results from it than from the appointment of a special committee of the American Society of Microscopists to prepare a standard scale.

In conclusion, I readily admit that so long as the English microscopists continue to express the results of their measurements in decimals of an English inch, there will be American microscopists who will do the same, either for all purposes or for particular work, and of course it is very desirable that these measurements also should be accurate. The stage-micrometers on this system in the market are usually ruled in hundredths and thousandths of an inch. The latter divisions are too wide to give values to the eye-piece micrometer with the higher powers, while the five-thousandths, ten-thousandths, or even finer divisions, ruled also on some of these micrometers, are inconveniently close. I would advise the makers to rule such micrometers four-tenths of an inch long, divided into hundredths of an inch, one of the hundredths being subdivided into ten, another into twenty-five spaces. These latter spaces, each representing one twenty-five-hundredth of an inch, sufficiently approximate the hundredth of a millimetre to be used with equal convenience with the higher powers. The scale on the glass eye-piece micrometer, used with these stage-micrometers, should be, if specially made for the purpose, four-tenths of an inch long, divided into one hundred parts, each one two-hundred-and-fiftieth of an inch; but these divisions would so closly approximate those of the metric eye-piece micrometer proposed, that it might be used without inconvenience instead. Where it is thought worth while by a microscopical society to procure a standard scale of this kind, it should be sent to the Coast Survey Office for measurement, as in the case of the metric scales."

Rogers' Micrometers.—Prof. W. A. Rogers, of Cambridge, U.S.A., recently offered, as we announced,* to present a ruled stage micrometer to any one who would undertake to examine its divisions and publish the results. Mr. T. S. Bazley having accepted the proposal, now details the result of the investigation.† "Placed on the stage, and viewed with a two-thirds objective, and a dark field, the ruled lines, which are not filled in with a dark pigment as is common, sparkle like streaks of diamonds; and under this illumination a singular appearance is noticed. In some of the lines a slight internal splintering of the glass has apparently followed the course of the ruling-point, giving an effect of deeper cuts in certain places. But, as this effect is invisible with a bright field, and as there is certainly no variation in the width of the several lines, it probably arises solely from the nature of the glass; and the more so, as these apparently deeper cuts do not often extend for the entire length of a line, and sometimes occur side by side for a few lines.

"The micrometer is of the ordinary 3 by 1 size. The ruled portion is a centimetre in length, and contains 1000 spaces, subdivided at every fifth and tenth, the lines being thus 0·01 mm. apart. The width of the band, neglecting those lines that project, is 1·375 mm. Every tenth line is 1·6 mm. long, and the principal spaces of 6·1 mm. are subdivided by a shorter prolongation of the fifth lines, which measure 1·55 mm. These measurements are the average only, for the lengths of the individual lines vary a few thousandths of a millimetre, and the lower edge of the band is not consequently strictly in one straight line. The terminations of the lines at the upper edge, independently of those projecting at every fifth and tenth, are not in the same straight line either. These deviate in a symmetrical manner; four lines between two long ones having their ends equal and straight, while the ends of the next four form a gentle convex curve. All the lines at this, which may be considered the reading edge of the band, are terminated by singular hooks, suggestive of the curved handle of a walking-stick (see Fig. 24); they differ somewhat in size and character, but have all the same direction, and are probably due to the stopping, lifting, and reversal, of the cutting diamond.

FIG. 24.



"The objectives used were a series by several makers (dry, as well as immersion adapted to various media) up to Zeiss's L, equivalent to

* See this Journal, i. (1881) p. 678.
† Engl. Mech., xxxiv. (1881) pp. 341–2 (1 fig.).

$\frac{1}{24}$; the lines of the band being well defined under all of them; and the eye-piece micrometer, Jackson's form, and a small spider-line micrometer. The former depends a good deal for its result upon an estimation to tenths of its graduations, and can hardly be susceptible of the accuracy which should be attained with a well-made 'wire micrometer.' The latter was therefore adopted and provided with additional draw-tubes, for use, either as an eye-piece in the usual manner, or in the substage, giving an aerial image of the spider-lines as proposed by Dr. Pigott.* This latter method, however, so far as my own experience goes, is more ingenious than effective; principally because all vibration of the micrometer in that position is magnified by the whole power of the Microscope. There is one advantage possessed by Jackson's in the spring action, which moves the whole scale, and consequently its zero point, with extreme nicety. In the spider-line micrometer, one wire is generally fixed, and the only way to bring a given point of an object under the Microscope to coincide with that wire is by the screw action of the stage, which, with a high power, is far too sensitive and rapid. To obviate this difficulty, a traversing movement to the extent of a fifth of an inch, controlled by a screw of fine pitch, was added to the small micrometer between its screw-plate and draw-tube. By this means any given line on the ruled band, after being brought approximately into position with the stage movement, could be accurately bisected by the fixed wire of the micrometer. The objectives finally selected were a $\frac{1}{4}$ for the measurement of the principal subdivisions of 0·05 mm. each, and a $\frac{1}{10}$ imm. for the close spaces. These objectives gave the most convenient decimal values; the former by suitable adjustment of the draw-tube giving ·00025 mm. as the equivalent of one division of the micrometer divided head (50 divisions to one turn); and the latter ·0001 mm. Both glasses were by Beck, and their magnifying powers, with the positive eye-piece employed, were 950 and 2500 respectively. Of course the eye-piece could be changed at pleasure, without altering the ratio of scale to image. The fine movement of the Microscope employed is on its main tube; its action propels or withdraws the nose-piece, thus possibly interfering with the value, as adjusted by the lengthening draw-tube, of the micrometer scale in terms of a given unit. It proved, however, by actual experiment, using a power of 1000 diameters, that an alteration of the fiftieth of an inch in the distance from eye-piece to stage, made no perceptible change in the ratio between the micrometer in the eye-piece and that on the stage, so any supposed error in measurement from this cause may be dismissed as visionary. All kinds of illumination were tried, the preference being given to that described [in this Journal, I. (1881) p. 666], using the concave mirror without condenser, at an obliquity of about 40°, and a thin metal plate attached below the stage, at such an angle that no rays from the lamp can reach the object, except by reflection from the inclined mirror. With the light so directed, each line of the band was evenly divided, longitudinally, into a dark half and a light half, giving much facility for the exact superposition of a

* Mon. Micr. Journ., ix. p. 3.

micrometer-wire upon the centre of the image of any line. In examining the spaces seriatim, there was some risk of losing count, and as a means of reference, a scale of figures, photographed by Mr. J. Mayall, jun., to the exact length of a centimetre, was pasted at the upper edge of the band, so that the principal graduations of the latter could be identified with a low power.

"Coming, at last, to the examination of the plate ruled by Prof. Rogers, perhaps its most distinguishing feature is the perfect straightness and similarity of the individual lines. The stage micrometers commonly met with are so deficient in this respect, that it is impossible to obtain equal distances from different parts of the same two lines of the scale. But with the rulings of Prof. Rogers no such inequality exists. The spider-lines at the eye-piece may be set to any interval of lines on his micrometer, and the scale will rigidly indicate the same distance at any other part of the band, whether above, below, or on either side the position first selected. As to the actual width of the lines themselves, I make it to be ·001 mm. almost exactly. After all these precautions for the study of this micrometer, perhaps a list of small, though definite, errata may be looked for; but I have carefully verified the principal intervals of the band, and a large number, taken at hazard, of the 1000 close spaces, and have detected no discrepancies whatever. The only possible criticism that occurs to me is that the projecting lines at the reading edge are perhaps needlessly long, and that if the 'walking-stick hooks' could be transferred to the other side of the band, it would be an improvement. I believe the ruling to be as accurate as mechanical means can produce; and though there is no means of deciding whether the spaces are true subdivisions of the French metre, the perfection of the subdivisions themselves is a tolerably sure guarantee that the Professor took every care to verify his unit to begin with."

Section of "Histology and Microscopy" at the American Association.—At the last meeting of the American Association for the Advancement of Science, a section of "Histology and Microscopy," in place of the previously existing sub-section of Microscopy, was established, to rank on the same footing as the other sections of the Association, and to be represented on the Standing Committee, its Chairman being *ex officio* a Vice-President.

Structure of Cotton Fibre.*—Dr. F. H. Bowman has published an elaborate investigation into the structure of cotton fibre, in which he gives a general account of the plant botanically, and deals with the typical structure of a cotton fibre, both in regard to the mechanical arrangement of its ultimate parts, and chemically. A full consideration is given to the variations from the type structure which are found to exist and the extent to which any variation in the ultimate fibre may affect its use in the manufacturing process.

The book is illustrated with plates of typical and other cotton

* Bowman, F. H., 'The Structure of the Cotton Fibre in its relation to technical applications,' xvi. and 211 pp., 5 figs. and 12 pls. 8vo, Manchester, 1881.

fibres and with coloured plates, showing their appearance when dyed with turmeric yellow, indigo blue, &c.

The value of the Microscope with ordinary and polarized light, and with dyed and undyed fibres, is throughout made a special feature, and the book is to be welcomed as a noteworthy addition to the, at present, very scanty literature relating to the practical applications of the Microscope to manufactures. We should imagine that both silk and woollen manufacturers would be benefited by similar treatises on silk and wool.

The limit of microscopical *vision* is, on pp. 156–7, treated as synonymous with the limit of microscopical *resolution*, and in any future references to the subject care should be taken to show that the latter refers exclusively to the power of distinguishing as separate two lines or other objects close together, the limit of which is half the wave-length in the medium employed $\times$ sin. u, whilst the vision of isolated minute objects is only limited by the sensitiveness of the particular observer's retina, the distribution of light, &c. Limit of "visibility" is distinct from the limit of "visible separation."

β. Collecting, Mounting and Examining Objects, &c.

Durable Preparations of Microscopical Organisms.*—Professor G. Entz describes the method used by him for mounting microscopical organisms, Protozoa, Rotifera, &c., preceded by an historical review of the processes hitherto adopted.

Ehrenberg † used a dry process which answered well only for certain objects. Its use may be somewhat extended by soaking the dried preparation in 1 part distilled water, 1 part glycerine, and (in a large quantity) 1–2 drops of picric acid. The shrivelled parts swell out and look very life-like. Amongst the organisms capable of being so treated are the Volvocineæ, Chlamydomonads, the loricated *Euglenæ* (*E. acus* and *E. Spirogyra*) Peridineæ, the tests of Rhizopods, tubes of *Melicerta*, Ciliata with resisting cuticles (as *Stentor igneus*, *Epistylis plicatilis*, and fine chitinous elements, such as the masticatory apparatus of Rotifera and small Nematodes. The protoplasmic parts of organisms are of course entirely lost by this method.

Later still, Du Plessis ‡ suggested glycerine coloured with chromate of potash, and Duncker § in 1877 exhibited Rotifers, Protozoa, and Algæ, which were highly commended by such authorities as Cohn, Stein, and Leuckhart, and which showed the fine parts in a most wonderful manner. Unhappily they were not permanent. In a few weeks brown oily drops began to make their appearance in the fluid, and ultimately the protoplasm also browned, so that they are now useless. Duncker never published his method, but the author considers it probable that the basis of the fluid he used was rectified

* Zool. Anzeig., iv. (1881) pp. 575–80.
† Abh. K. Akad. Wiss. Berlin, 1835, p. 141; 1862, p. 39.
‡ Arch. f. Naturg., 1864, ii. Band, p. 162.
§ See this Journal, i. (1878) p. 221.

pyroligneous acid, which, allowed to run in under the cover-glass in small quantities, killed and fixed the organisms in their natural form.

After referring to the methods suggested by Certes,* Bütschli,† and Thanhoffer and Davida,‡ the author describes that which he has adopted in the hope of obtaining the same beautiful results as Duncker, but at the same time more durable.

"According to my experience, various means, long known, are adapted for fixing the smallest and most delicate organisms; for instance, rectified pyroligneous acid, the 'liqueur salin hydrargyrique' of Blanchard, in the mixture which Arnold Lang recommends for preserving marine Planarians, § and which has been also used by Paradi for fixing fresh-water Turbellarians with the best results; also picric acid; and lastly, what Paul Mayer has so strongly recommended || for the lower animals, viz. picro-sulphuric acid, which certainly should have the preference over the others. All these media (the list of which is by no means exhausted), kill microscopical organisms instantaneously, without destroying their organization. Flagella and cilia, the suctorial disks of the *Acinetæ*, and even the fine pseudopodia of the Heliozoa can be fixed as well as the pedicel of the rapidly-jerking *Vorticellæ*. Also the muscle of the pedicel, the contractile vacuoles, and the œsophagus and digestive vacuoles. *Euglenæ* and *Amœbæ* may be fixed in their various changing shapes. Rotifera die mostly with their peristomes moderately withdrawn, and *Vorticellæ* the same; but examples may be obtained from *Carchesium*- and *Epistylis*-stems, which are fixed in the act of lively rotation. Infusoria are fixed in the same life-like state, in the act of fission or conjugation, and *Vorticellæ* in the bud form of conjugation. The nucleated elements also come out very prominently, even the nucleolar capsules can be splendidly preserved for further study, and their striation retained. *Spongillæ*, *Hydræ*, small Nematodes, Tardigrades, delicate insect larvæ, and ciliated cells (e. g. of the gills of mussels) can be excellently fixed and preserved. To obtain durable preparations, however, it is absolutely necessary to remove the fluid which has completed its work in the process of fixing, as it might injure the fine organisms by longer action, afterwards placing the preparation in a fluid which is suited to it.

"My procedure is essentially the same as that which Paul Mayer used for treating the lower marine animals with picro-sulphuric acid.

"I place the Protozoa and other microscopical organisms with the Algæ, sediment, or other objects to which they are affixed or between which they move, with some water in a watch-glass, then drop in a few drops of the fixing fluid, which I allow to act only 1–2 minutes. I then pour off the fluid carefully, or simply lift the

* Comptes Rendus, lxxxviii. (1879) p. 433. See this Journal, ii. (1879) pp. 331 and 763.

† Zool. Jahresber., 1879, p. 173.

‡ Thanhoffer, L. v., 'Das Mikroskop und seine Anwendung,' 1880, p. 110.

§ Zool. Anzeig., i. (1878) p. 14. See this Journal, i. (1878) p. 256.

|| MT. Zool. Stat. Neap., ii. (1880) pp. 1–27.

preparation out with a pencil or scalpel, in order to transfer it at once into a larger quantity of alcohol, which must not be too strong. Half an hour is usually enough to withdraw the fixing fluid and replace it by alcohol, in which it may remain a longer time without damage. For removing the chlorophyll colouring-matter of many Infusoria, and also the Algæ in the preparation, a longer stay in alcohol is of course necessary, replacing it by clear alcohol when it has become coloured.

"Microscopical organisms thus treated are ready to be at once mounted in dilute glycerine (1 part of distilled water to 1 of glycerine). But colouring must not be neglected. Among the colouring materials commonly used (carmine, hæmatoxylin, and various aniline dyes), carmine certainly is to be preferred, because it is not bleached in glycerine, and moreover does not colour everything with one tint like the aniline dyes, but principally the nuclear elements. Preparations transferred from alcohol to carmine are mostly coloured sufficiently in 10–20 minutes, only loricated forms as *Euglena*, *Spirogyra* and species of *Phacus*, the Peridineæ, &c., require several hours to make their nuclei sufficiently prominent. Before being transferred into dilute glycerine, the preparations must of course be put into distilled water, and remain until the yellow picric acid is drawn out, and the preparation shows a nice rose colour.

"By the above process beautiful and instructive preparations are obtained, which when carefully mounted show no further change. I have a fairly considerable collection of different Protozoa which have not altered in the least for 6–7 months, and are adapted both for demonstration and for detailed study."

Preparing Anthers.*—J. Rataboul proposes an improved method for preparing anthers, to show the fibrous cells of their walls.

The ordinary method of preparation is to leave the anthers in water until the walls swell, and by triturating with a quill to loosen some shreds of tissue. If any cells are found the tissue must be washed with care to remove pollen-grains and air-bubbles. These manipulations are long, delicate, and difficult, and are not always successful; and the author's method is to place the anthers in 90° or 100° alcohol for 4–5 minutes, triturating *grosso modo*, and immediately putting it in distilled water. The cells open as if by enchantment, the pollen-grains are readily detached, the alcohol dissipates the air-bubbles, and by this process a much larger portion of the anthers can be obtained for examination.

Herpell's Method of Preparing Fungi for the Herbarium.†—G. Herpell announces some improvements on his method previously published, and which we have already described.‡

In the method proposed for the preservation of the fleshy parts he has no improvement to suggest; but in the preparation of the spores various slight emendations have presented themselves.

* Bull. Soc. Belg. Micr., vii. (1881) pp. cxliv–v.
† SB. Bot. Ver. Prov. Brandenburg, June 24, 1881.
‡ See this Journal, i. (1881) p. 136.

The fixing of the coloured spores with lac on white paper answers completely; but, in the case of the Leucospori, only those of species of *Russula* and *Lactarius* unite firmly with the resin of the lac. On the other hand, the mode of fixing the white spores on blue cardboard simply with gelatine appears to answer in all cases; but the solution should be somewhat more dilute than previously stated. The best fluid is a warm solution of 1 part gelatine in a mixture of 150 parts water and 150 parts alcohol. This answers with species of *Russula* and *Lactarius*, while with *Agaricus* (*Collybia*) *radicatus* so concentrated a solution as 1 part gelatine in 30 parts water is necessary. The writer gives a list of a number of species, with the strength of solution required in each case. Some spores can be fixed on blue cardboard by the use of pure water only. In some cases, again, it is necessary to heat the solution strongly. *Agaricus* (*Collybia*) *maculatus*, *A.* (*C.*) *velutipes*, and *Marasimus peronatus* require a different treatment, which is described.

The author found the same results with the fluid recommended by Patouillard (2 parts mastic in 15 parts ether) as with the lac; the resin does not in all cases combine well with the white spores. The ether has some advantages in penetrating the paper more rapidly and completely, but, on the whole, Herpell prefers the use of alcohol.

Dissociation of Gland-Elements.*—Cauderau finds boiling the mucous membrane of the stomach in a solution of nitrate of soda a very good process for isolating the glands and gland-elements, but the constituent parts of the tissues become too brittle. This defect can be obviated by a previous immersion of some minutes in osmic acid. The cells will then remain admirably preserved after boiling for three hours, but can scarcely be stained at all. The following combination is therefore recommended:—One part of Müller's fluid is diluted with two parts of water and about 30 to 40 grammes of the sodic nitrate is dissolved in a litre of the mixture. Boiling for three hours in this compound is sufficient to break up the mucous membrane of the stomach. The maceration, besides acting on the glands, extends to the muscular coat.

Method of Preparing and Mounting Soft Tissues.†—The conclusions arrived at with regard to the structure of the nervous centres by means of the successive action of bichromate of potash and nitrate of silver will certainly receive confirmation from this method, which we owe to Professor C. Golgi. It has the double advantage of enabling us to stain the nerve-cells black within a given time, and of turning out preparations which may be kept for a long period in the ordinary mounting media.

The pieces of tissue are hardened to the necessary degree in Müller's fluid, or in solutions of bichromate of potash, whose strength

* Gaz. méd. de Paris, No. 45, pp. 577–8. Cf. Jahresber. Anat. u. Physiol., viii. pp. 13–14.

† Rendiconti R. Istit. Lombard., xii. pp. 206–10. Cf. Jahresber. Anat. u. Physiol., viii. pp. 12–13.

is gradually increased from 1 to $2\frac{1}{2}$ per cent. The pieces must not be more than 1 to 2 cm. thick, a large proportion of fluid must be used, and it must be frequently changed. In from 15 to 20 days the pieces are put into corrosive sublimate solution $\frac{1}{4}$ to $\frac{1}{2}$ per cent. in strength. The reaction requires at least 8 to 10 days, and during this time the liquid must be daily renewed. The pieces gradually change colour and acquire the appearance of fresh brain-substance. They may be allowed to remain even for a longer time in the solution, which serves at the same time to harden them. Sections which are to be kept must be repeatedly washed, else crystals and other deposits appear upon them and alter the appearance under the Microscope. They keep admirably well in glycerine, which is perhaps better for the purpose than Canada balsam and dammar. By this method the ganglion-cells with their processes are acted upon; their nuclei are often left visible; the elementary constituents of the walls of the vessels, and especially the smooth muscular fibres (muscle fibre-cells), are also brought out. Golgi reports having had good results from the application of this treatment to the cortex of the cerebrum, negative results in the case of the spinal cord, and but slight success with the cerebellum. The author calls the reaction an *apparently black* one, inasmuch as the elements on which it has taken effect appear white under surface illumination, and black only by transmitted light.

Preservation of Anatomical Specimens.*— L. Gerlach recommends the glycerine process of Van Vetter, which has been somewhat modified, firstly by Stieda and then by Gerlach himself. Stieda's recipe is as follows:—Make a mixture of 6 parts of glycerine, 1 of brown sugar, and $\frac{1}{2}$ part of saltpetre; Gerlach uses 12 instead of 6 parts of glycerine. The preparations are cleaned and laid in this liquid, in which they remain from three to six weeks, according to their size. When taken out they have a dark-brown colour and are quite firm; they are then hung up in a chamber of the temperature of 12°–14° R. (59° to $63\frac{1}{2}$° Fahr.). In the course of eight to ten days they become soft and flexible, but must be allowed to hang from two to six months longer, to be available for demonstrations. The more glycerine used, the lighter in colour the preparations remain. The method is best applied to preparations of articulations, to sense organs (eye, ear), larynx, &c. The formation of a crystalline precipitate, which sometimes appears in the drying, is met by the increase in the proportion of glycerine and a diminution of the saltpetre and sugar. If large objects are to be set up, such as whole extremities with their muscles, or the thorax with the ligaments dissected, pure glycerine is preferable to the cheap crude article, for specimens turn out whiter and less hard in it. Gerlach has used it for temporal bone with tympanum and auditory ossicles, and obtained valuable preparations which may be employed with great success to demonstrate the transmission of waves of sound from the tympanum to the labyrinth.

Barff's Preservative for Organic Substances.—A new preservative applicable to all animal and vegetable substances has been

* SB. phys.-med. Soc. Erlangen, July 28, 1879. Cf. Jahresber. Anat. u. Physiol., viii. pp. 112–13, and Jahresber. (Virchow and Hirsch) for 1879, p. 2.

patented by Professor F. S. Barff. It is a compound prepared by mixing boracic acid with glycerine. The former is dissolved in the latter by the aid of heat, the solution taking about four or five hours, care being taken, however, that the temperature employed shall not be so excessive as to decompose the glycerine. To such solution or compound a further quantity of boracic acid is added from time to time until the boracic acid ceases to be dissolved. The compound resulting when allowed to cool, is solid, and is called by the patentee boroglyceride.

In order to employ the compound, a solution is prepared in water, alcohol, or other suitable solvent, and the organic substances to be operated upon, either immersed in or impregnated with such solutions. Solutions may be prepared of various degrees of strength; but Professor Barff finds that a solution consisting of about one part by weight of the compound and forty parts by weight of water will give good results; other proportions may, however, be adopted for special purposes. Solutions of the compound may be applied to the preservation of all organic substances either animal or vegetable.

Injection-mass.*—L. Teichmann injects blood-vessels and lymphatic vessels with a mass which is fluid when cold; it is made with finely powdered materials and linseed-oil varnish up to the consistency of putty, and altered to that of honey or syrup as required, by volatile liquids (such as ether and carbon disulphide). Prepared chalk, zinc white, &c., may be used, coloured with cinnabar, ultramarine, chrome yellow, &c. Ordinary hand-pressure is not powerful enough, so Teichmann makes use of syringes, such as those for injecting gutta-percha, in which the piston is impelled by a screw arrangement.

In this way, even the finest and most elaborate ramifications of the vessels may be readily and with certainty filled. The mass soon stiffens, partly owing to transudation, partly to evaporation of the ether, so that it does not ooze from vessels which may be cut through; it remains soft for a certain time and is as hard as stone when the preparation is finished. The advantages of this method are obvious.

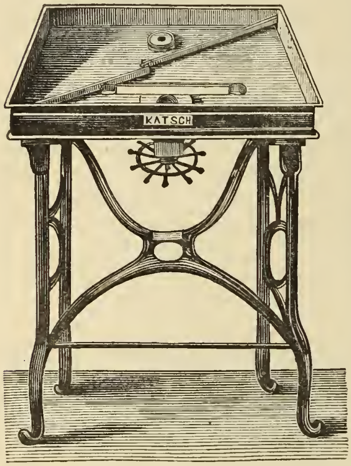
Imbedding Delicate Organs.†—L. Frédéricq describes a method by which pieces of tissue or organs, such as brains of small animals, livers, kidneys, &c., are so thoroughly impregnated with paraffin that they retain a firm consistence, do not shrink up, and keep as well as the best casts of the organs. The tissue or organ is hardened by placing in alcohol, first dilute, then absolute, for several days, is then laid for several days in oil of turpentine, until transparent, when it is transferred to paraffin melted in a water bath, and kept there at a temperature of about 55° C. (it must not exceed 60°), for from two to eight hours, according to the size of the object. It is removed and dried while hot in a current of steam, by blotting-paper or otherwise, and finally allowed to cool.

* SB. Math. Kl. Krakau. Akad., vii. pp. 108–58. Cf. Jahresber. (Virchow and Hirsch) for 1879, p. 2.

† Gaz. méd. de Paris, 1879, No. 4, pp. 45–6. Cf. Jahresber. Anat. u. Physiol., viii. p. 12.

Katsch's Large Microtome.*—In this instrument (Fig. 25), a stand, similar to that of a sewing-machine, supports a tray, across which, in a diagonal direction, a small ledge is fixed. This is inclined rather outwards, and on one end of it the cutting knife rests, so as to move steadily against the microtome plate which rises a little above the tray, and surrounds the preparation. The plate itself is at the end of a hollow cylinder fixed to the tray, in which a massive metal cylinder can be raised and lowered by a screw underneath. There are three knobs on the upper part of this cylinder to fix the substance in which the preparation is imbedded.

Fig. 25.



When the latter is cooled (which is done by pouring water into the tray) the section can be made.

A special advantage of this form of instrument is that sections can be cut under water, and that the screw may be fixed by means of a small click to the $\frac{1}{5000}$ mm. In turning the screw the click is caught at every $\frac{1}{5000}$ mm., and gives an audible signal.

Cox's "Simple Section-cutter for Beginners."†—In this, economy and simplicity have been carried to at least their furthest practicable limits, as the basis of the instrument is a sewing-machine cotton-reel, and a Perry's music binder. The cost does not exceed 2 or 3 pence.

Cutting Sections of very small Objects.‡—H. Strasser adds from 3 to 4 parts of tallow to the imbedding mixture recommended by Kleinenberg (spermaceti 4 parts, castor-oil 1 part), and in order to be able conveniently to arrange very small objects for cutting sections in any required position, he places them in the mass while this is still warm, between plates of mica; the temperature must never exceed 45° C. After cooling the mica plates may be readily separated from the mass, which has the form of a thin sheet, and contains the object; it may be then fixed with heated pins in the desired position upon a block of a substance not easily melted.

Mounting in Balsam.§—Dr. C. Seiler, in a paper contrasting glycerine and balsam as mounting materials, gives the following as a desirable modification of the old process of mounting in various

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 96–7 (1 fig.).
† Ann. Rep. Postal Micr. Soc., 1881, pp. 12–13 (1 fig.)
‡ Morphol. Jahrbuch, v. (1879) p. 243. Cf. Zool. Jahresber. Naples, i. (for 1879) p. 35.
§ Proc. Amer. Soc. Micr., 1881, pp. 60–2.

media, whereby the disadvantages attendant upon the use of balsam are removed, so that it becomes the preferable method.

Take a clear sample of Canada balsam and evaporate it in a water or sand bath to dryness; i.e. until it becomes brittle and resinous when cold. Dissolve this while warm in warm *absolute* alcohol (Squibbs'), and filter through absorbent cotton. Place the section, after it has been stained, in weak alcohol (about ·60), and allow it to remain in a few minutes, then transfer it to ·80, ·95, and finally to absolute alcohol, in which it should remain a few minutes also. Then transfer it to the slide (which has been slightly warmed above a spirit-lamp so as to remove all moisture), drain off all superfluous alcohol, and place a drop of the alcoholic balsam solution on the specimen. In a few seconds the latter will become transparent, when it may be covered, and set aside to dry. In damp weather, or when breathed upon, a milky edge will be noticed on the drop of balsam, which is caused by minute globules of water, which, however, may readily be dispelled by the application of a little heat to the under side of the slide. It will be seen that by the *gradual* dehydration of the specimen, the danger of distortion of the histological elements is materially diminished; that by the omission of any clearing agent the shrivelling is avoided as well as the solution of fat in the cells prevented, for cold alcohol alone will not dissolve fat; and finally by evaporating the balsam to dryness all other constituents except the pure balsam are driven off, so that the danger of crystallization is avoided.

Mounting in Glycerine.*—Dr. S. R. Holdsworth finds the following plan to be efficacious in avoiding the difficulty found in getting rid of the surplus glycerine when it has passed beyond the cover-glass. He puts a very small drop of glycerine upon the object, just sufficient that when the cover-glass is applied it will not extend to the margin. A solution of Canada balsam in chloroform or benzoline is then run in to fix the cover-glass, and not being miscible with the glycerine, an air-space is formed between the two fluids which has not been found to be detrimental. The slide can be finished with a ring of balsam or other cement.

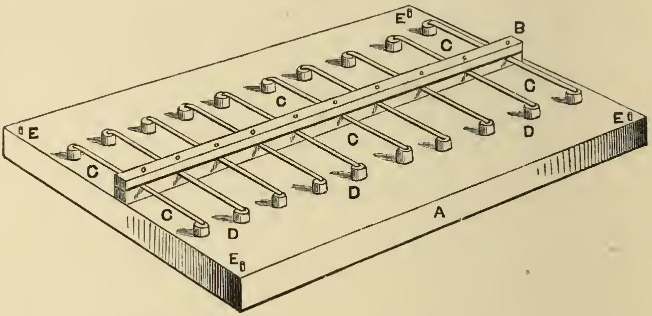
Smith's Slides.†—The Editor of the 'American Monthly Microscopical Journal' writes:—"Mr. J. Lees Smith, of this city, has prepared some very attractive slides in this manner: the glass slips are first coated with photographer's 'granite varnish' by flowing, just as a plate is coated with collodion in photography. This coating of varnish gives the slide the appearance of finely ground glass. It is then placed on the turntable, and, by means of a knife-blade, the varnish is entirely removed from a circular spot in the centre, just large enough for the cell in which the mount is to be preserved. The preparations we saw were mounted in glycerine, and the clear and transparent cells were made of Brown's rubber cement, which Mr. Smith regards as a most excellent cement, especially for glycerine

* Ann. Rep. Postal Micr. Soc., 1881, p. 11.
† Amer. Mon. Micr. Journ., ii. (1881) p. 179.

mounts. Imagine a slip of ground glass with a transparent spot in the centre, upon which objects can be mounted, and one can thus form an idea of the appearance of these slides."

Spring Clip Board.*—Mr. W. Stringfield gives the accompanying sketch (Fig. 26) of the spring clip boards he has had in use for some time, and which, for reducing the breakage of thin glass covers to a minimum, economy of construction, and convenience of moving, far

Fig. 26.



surpass, he considers, any arrangement that has come under his notice. They are made of mahogany, but of course pine or other wood can be used. All, however, should be baked previously to finally planing up. A is a piece of mahogany $12 \times 7\frac{3}{4} \times \frac{3}{4}$ inches; B two strips, each securely fastened down the centre of the base board A by eleven screws; C C pieces of watch or crinoline steel, $3\frac{3}{4}$ inches long, $\frac{3}{8}$ inch wide, with a hole punched in either end to allow of a small brass pin passing through for securing the pressers; D D small pieces of phial corks; E E E E four screws fitting in corresponding holes drilled in the bottom of each board, thus allowing a number to be placed one on the other without injury to the slides, and admitting a free current of air.

Examination of Living Cartilage.†—J. M. Prudden found the episternum of the frog, especially of *Rana temporaria*, an extremely good object in which to examine cartilage in the living animal. A moderately curarized frog should be taken, and an incision made in the skin from the lower jaw to the middle of the sternum, and then two cross cuts; the operator must turn back the edges of the skin, and divide the submaxillary muscle, thus exposed, near the middle, avoiding the large veins which pass inwards over the apex of the episternum. The latter lies at the bottom of the incision, being covered only by a somewhat loose connective tissue. If the delicate laminæ of connective tissue between the episternum and hyoid bone are now cut through, and the head turned back at right angles to the body, the episternum is extruded from the wound, projects forwards,

* Sci.-Gossip, 1881, p. 232 (1 fig.)
† Virchow's Archiv, lxxv. pp. 185–98. Cf. Jahresber. Anat. u. Physiol., viii. pp. 11–12.

and may be rendered accessible even to strong magnifying powers if placed on a glass block of suitable size. For prolonged observations the whole object may be attached to Thomas's object-holder, with arrangement for irrigation, and may be kept in the natural fresh condition of life by irrigating with amniotic fluid or $\frac{1}{2}$ per cent. salt solution.

By this method Prudden was able, by irrigating with the latter fluid, to observe the cartilage cells in the episternum of the frog for many hours, in the living and fresh condition. Under these circumstances the intercellular substance appears homogeneous, the outline of the cell is very clear, and the cell-protoplasm has a finely granular appearance, with bright globules near the nucleus; the latter has a double contour, is penetrated internally by a number of fine lines, which meet at broader internodes. In this form of nucleus he could observe phenomena of movement, but could not determine that any effect was produced upon these movements by weak chemical reagents, by heat, or by electric currents. Under the action of 1 to 3 per cent. salt solution the cells shrink back from their walls, and are seen to be provided with numerous processes, which radiate to the walls of the cavities; vacuoles are also formed in the interior of the cells under these circumstances. When water is added to the solution, the cells resume their original appearance. Similar production of vacuoles under pathological conditions in cells, which have in like manner the power of reverting to the normal condition (Swetsky), the author believes to be explicable by an increase in the density of the liquid which the tissues contain. If the living episternum is irrigated with indifferent liquids and then replaced, the cells appear quite unaltered at the end of nine weeks.

In an episternum which had been excised and placed in the lymph sac of a frog, the cells were found to be filled with yellow drops, soluble in ether, after five days, and the cell-nuclei stained with carmine. An identical degeneration of the cells, accompanied by susceptibility to staining with carmine, took place when the episternum was exposed and replaced after its cells had been killed by chemical reagents or electric shocks. Carmine did not stain the nuclei at all in the living cartilage, neither after irrigation with 2 per cent. salt solution, nor after subsequent dilution of this liquid with water, nor when the episternum had been restored to the body for some weeks; consequently the cells had not died. The author found that even very weak solutions of iodine, and also carbolic acid solutions of a greater strength than $\frac{1}{4}$ per cent.—that is, solutions which are actually employed in the treatment of affections of the joints—caused the immediate death of the cells, so that when the tissue was subsequently replaced the degenerative processes just mentioned set in. The author found that the cells of living cartilage collapsed under a temperature of 53° C., in detached pieces at that of 50° C., a lower temperature than that which Rollet found necessary.

Statoblasts of Lophopus crystallinus as a Test for High-power Objectives.—Areolations of Isthmia nervosa.—Dr. John Anthony writes:—"I forward an object which I think will be found of value

as a test for high-power objectives, and which, not being a diatom or very diaphanous, needs rather the quality of 'resolution' than that of 'definition' to deal with it satisfactorily. I take it that a 'test' to be of use should be fairly easily obtainable; that the specimens should, from the nature of the structure, be uniform; and that to merit the name of a 'test' it should not be *too* easily made out, even by the best modern glasses.

"I am sanguine enough to think that the statoblast of *Lophopus crystallinus*, which is easily procurable in any numbers, will be found to meet these conditions. The difficult part is the structure of the membrane, which seems to be stretched over the coarse hexagonal framework of the statoblast. I have seen it well, but it tried my fine $\frac{1}{25}$ of Tolles, and was most bright and clear with an excellent $\frac{1}{10}$ homogeneous-immersion objective, which Mr. Tolles has just sent to me. I found the more axial the illumination the better—obliquity was fatal. I used a cap on my condenser of $\frac{3}{16}$, the diameter of condenser being $\frac{1}{4}$, and it evidently aided the definition.

"While on high-power testing, let me say that the hexagonal areolations seen in the apparent openings in *Isthmia nervosa* are valuable for trying the qualities of $\frac{1}{8}$, $\frac{1}{10}$, and $\frac{1}{16}$ or more. The areolations are not small, but so delicate as not to be seen at all by a poor object-glass, while the better the quality of objective the more clearly can they be made out, till they look like delicate network. I mention this because I find the existence of this delicate structure is not generally known; though I have used it for some years to try the quality of objectives."

Microscopical Structure of Malleable Metals.*—The following observations have been made by Mr. J. V. Elsden on the minute structure of metals which have been hammered into thin leaves. Notwithstanding the great opacity of metals, it is quite possible to procure, by chemical means, metallic leaves sufficiently thin to examine beneath the Microscope, by transmitted light. Silver leaf, for instance, when mounted upon a glass slip and immersed for a short time in a solution of potassium cyanide, perchloride of iron, or iron-alum, becomes reduced in thickness to any required extent. The structure of silver leaf may also be conveniently examined by converting it into a transparent salt by the action upon it of chlorine, iodine, or bromine. Similar suitable means may also be found for rendering more or less transparent most of the other metals which can be obtained in leaf.

An examination of such metallic sections will show two principal types of structure, one being essentially granular, and the other fibrous.

The granular metals, of which tin may be taken as an example, present the appearance of exceedingly minute grains, each one being perfectly isolated from its neighbours by still smaller interspaces. The cohesion of such leaves is very small.

The fibrous metals, on the other hand, such as silver and gold, have a very marked structure. Silver, especially, has the appearance

* 'Nature,' xxiii. (1881) p. 391.

of a mass of fine, elongated fibres, which are matted and interlaced in a manner which very much resembles hair. In gold, this fibrous structure, although present, is far less marked. The influence of extreme pressure upon gold and silver seems to be, therefore, to develope a definite internal structure. Gold and silver, in fact, appear to behave in some respects like plastic bodies. When forced to spread out in the direction of least resistance their molecules do not move uniformly, but neighbouring molecules, having different velocities, glide over one another, causing a pronounced arrangement of particles in straight lines.

This development of a fibrous structure, by means of pressure, in a homogeneous substance like silver, is an interesting lesson in experimental geology, which may serve to illustrate the probable origin of the fibrous structure of the comparatively homogeneous limestones of the Pyrenees, Scotland, and the Tyrol.

Sections of Fossil Coniferous Woods.—Voigt and Hochgesang of Göttingen have issued (price 65 marks) a collection of seventy microscopic slides of coniferous woods, fossil and recent, prepared by Professor Göppert. The present collection is a first instalment only, and is devoted to the Araucarieæ. Where possible, each species is represented by three sections, one transverse, the second central or radial, and the third cortical or tangential. Sections of recent woods are placed side by side with those of the most nearly allied fossil woods; as sections of an *Araucaria* (*A. Cunninghami*) and of a *Dammara* (*D. australis*) by the side of the fossil *Araucarites*. The preparations are arranged in a polished mahogany box with ledges, and have been made on slides of white glass 50 × 33 mm., and 1·5 mm. thick, with polished edges, under square cover-glasses of 18 mm. length and breadth, in Canada balsam. Only those of the recent Araucarieæ are under round cover-glasses of 20 mm. diam. in glycerine. The sections have been made with the greatest care and skill. Instead of the ordinary length of about 4 mm., these are of double or treble that length, so as to render possible a more complete examination. Special care has been taken to furnish sections which illustrate the nature of the process of petrifaction.

Aeration of Laboratory Marine Aquaria.*—The plan shown in Fig. 27 is recommended by M. Kunckel d'Herculais for aerating a salt-water aquarium by means of a fall of fresh water.

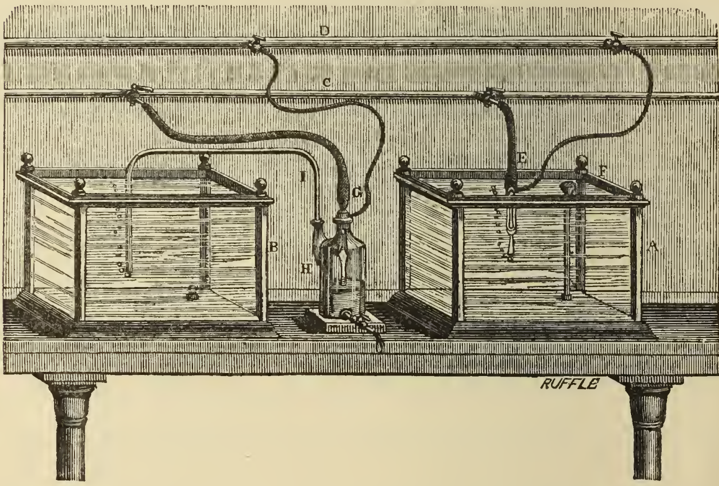
The figure shows two aquaria, A being fresh-water and B salt-water. In the first case the process is of course very simple, the water from the pipe C passing down the tube E, air being obtained through the tube F and pipe D which communicates with the open air so as to prevent air being abstracted from the confined laboratory.

In the case of the salt-water aquarium B, the fresh-water passes from the pipe C down the tube G into the bottle H, with three openings, which holds about two litres, air being obtained as before from the open air through D and the tube shown on the right. A

* See 'Manuel de Zootomie,' par A. Mojsisovics, traduit par J. L. de Lanessan (8vo, Paris, 1881), pp. 61–6 (1 fig.).

third tube I conducts the air from the bottle to the aquarium, while the water escapes from the bottle through the tap at the bottom. All that is necessary is to regulate the flow into and out of the bottle in such a way that the water shall be at a constant level. When this has once been experimentally ascertained the aquarium may be left

Fig. 27.



without fear day and night. If the bottle were allowed to get empty the aeration would of course stop, while if it were filled the fresh water would pass into the aquarium. In order to supply the loss from evaporation a little fresh water should be added from time to time, which will prevent the necessity for renewing with salt water.

The apparatus will pass $22\frac{1}{2}$ litres of air per hour through an aquarium of 90 litres at an expenditure of water of 36 litres. In this case the exit tube for the air, 5 mm. in diameter, is plunged 11 cm. into the aquarium. If the tube is plunged lower, say 36 cm., the pressure of the water which obstructs the exit of the air is greater, and 45 litres of water would be expended in passing 16 litres of air, i. e. 9 litres of water more, and $6\frac{1}{2}$ litres of air less. In the author's opinion, apart from the increase in the expenditure of water, it is undesirable that the air tube should go to the bottom of the aquarium, as the disturbance to the water which is thus caused is unfavourable to the development of delicate animals.

To ensure that the air-bubbles shall be small, the air tube is terminated by a small sphere with half-a-dozen very small orifices at its equator, and enveloped with two or three thicknesses of muslin.

PROCEEDINGS OF THE SOCIETY.

Meeting of 14th December, 1881, at King's College, Strand, W.C., The President (Professor P. Martin Duncan, F.R.S.) in the Chair.

The Minutes of the meeting of 9th November last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donor.

	From
Micrographic Dictionary. 4th ed. Parts 4–6.	*Mr. Van Voorst.*

Mr. Crisp exhibited Parkes' Drawing-room Microscope with magnetic stage, and two bottles from Professor H. Van Heurck, of Antwerp, containing new fluids for use with homogeneous-immersion lenses; one ("liquide homogène à la tacamaque") with a refractive index of 1·510, and a dispersive power of ·0072, and the other ("à l'oliban) of the same index, but with a dispersive power of ·0077.

Mr. John Mayall, jun., exhibited Mr. Deby's method of turning the correction-collar of objectives, the chief peculiarity of which was, that the collar was worked by a tangent screw (with a long arm) acting upon a worm-wheel, instead of by the ordinary collar-adjustment, which Mr. Deby had found to be inconvenient (see p. 107). As at present made, it would not go into an ordinary box, but (as had been pointed out by Mr. Beck) the screw pinion might be considerably shortened, so as to admit of its being put in a box in the usual way.

Mr. Beck said that it must be borne in mind that in adjusting an object-glass it was often desirable to get a sudden adjustment, which could not be very well done with this form.

Mr. T. Charters White described, by means of black-board drawings, a new form of growing or circulation slide which he had recently devised, and exhibited the slide in action under a Microscope (see p. 19).

Mr. James Smith said he had been trying himself to work out some better form of growing-slide than those in common use, but his attempts had hitherto proved abortive. He was, however, very much pleased with the one now shown by Mr. White, the great advantage of which was its extreme simplicity, and its capability of keeping objects alive for any length of time.

The President thought that its only disadvantage would be that when carefully examining one particular individual, others might be

introduced into the cell by the flowing water. With some kinds of organisms there would, of course, be no such danger, but it would hardly be safe with an *Amœba*, for instance. He had himself found, when studying the life-history of minute species, that it answered very well to make a small cell of ordinary thin glass, and by surrounding the whole with blotting-paper, kept constantly wet, he had been able to retain three or four monads of large size under constant observation for several weeks. A similar arrangement to that adopted by Mr. White had been used on the human body as a means of applying evaporating lotions.

Mr. J. W. Stephenson said he had brought for exhibition some scales of insects (*Machilis maritimus* and *Tomocertus* [*Podura*] *plumbea*), mounted in phosphorus, and shown under a $\frac{1}{25}$-inch objective with very oblique light and the binocular. They demonstrated that it was possible even with such a high power to get with the binocular a distinctly stereoscopic effect, and that when so seen a much more perfect idea of the structure of the scale could be obtained than was possible under the monocular. Although the structure of the scales of *Machilis maritimus* and *Tomocertus plumbea* is probably the same, they cannot be said to be "corrugated" in either case. In *Machilis* the appearance of the upper side is that of longitudinal semi-cylindrical grooves, which had been likened by a medical gentleman to a pill machine; whilst the latter, probably from being so much smaller, appears to have rectangular grooves, similar to those in a curry-comb, the back being in each case supported by slender transverse bars, which are approximately from one-third to one-half the distance apart of the longitudinal divisions.

Mr. Beck said that as to the Podura scale shown by Mr. Stephenson, what he described with respect to the structure of the scales was entirely opposed to what they had been shown to be. In such matters where high powers and oblique light were used, he thought it was very doubtful if they ought to believe what they saw, as they might so very easily be deceived by appearances. So far as he knew, no one had hitherto brought forward anything which would refute what he had shown some years ago, when he put moisture on one side of a scale, and found that it dried off quite flat, whilst if he put some on the other side, it ran up and down as if in corrugations. His brother also did the same kind of thing with a *Lepisma* scale and Canada balsam. Moisture, as they knew, would get into slides which were mounted dry, and the same appearances were presented there. Having kept the insects, and being able to tell which was the upper, and which the under side of the scale, and being also able to show these corrugations in a mechanical way, he could only say that even if the effect could be seen as described by Mr. Stephenson, he should not, he was afraid, be convinced, for he knew very well that in most cases, by reversing the shadows, they could reverse the appearances. If they wanted to determine the real structure with high powers, they must argue from analogy rather than from what they saw. They had compound substances to deal with, and effects were produced which

had to be studied and analyzed and examined very carefully. Unless, therefore, any one could show upon the upper side what he had shown mechanically on the under side, he considered that the appearances obtained by simple vision were deceptive.

Mr. Stewart said he understood that some time since a microtome was made, so delicate in its adjustment as to be able to cut sections of a valve of a diatom. Could not this be made available for making sections of the scale which would show the configuration of it as conclusively as if done in the mechanical way?

Mr. Crisp said that the existence of such a microtome (cutting 150 consecutive sections of the brain of a cockroach) had been reported, and he had endeavoured to obtain it, but hitherto in vain. So far as he knew also, no results obtained from any actual sections had been published, other than those which appeared in the 'Archiv f. Mikr. Anat.' in 1870. The further and more recent series promised by Dr. L. Flögel * had not been heard of.

Mr. Stephenson said that notwithstanding Mr. Beck's remarks, he could not but feel clear as to its being the upper side of the scale on which these grooves were, for the pedicel or "quill" of the "feather," which is necessarily on the under side of the scale, was bent down from the plane of the scale, and the markings were clearly on the opposite side to that.

Dr. John Anthony's note was read by Mr. Stewart, suggesting the statoblasts of *Lophopus crystallinus* as a test for high powers (see p. 129). The difficult part was stated to be the structure of the membrane. The portions of the statoblasts referred to were drawn on the board and further explained by Mr. Stewart.

Mr. Guimaraens called attention to what appeared to be a male specimen of the *Echinorhynchus* of *Lota vulgaris* with ova in the interior, described as "dedans par hasard."

Mr. A. D. Michael read a paper, "Further Notes on British Oribatidæ" (see p. 1), which Professor Huxley and others state to be wholly viviparous. He found, however, that they are chiefly oviparous, as stated by Nicolet and others, and that the young are brought to maturity in, at least, four different modes:—1st. The egg is deposited in a slightly advanced stage, as in insects. 2nd. Deposited with the larva almost fully formed. 3rd. The female is occasionally viviparous (in these modes only one egg is usually ripe at a time). 4th. Several eggs are matured at once, but not deposited. The mother dies, the contents of her body, except the eggs, dry up, and her chitinous exterior skeleton forms a protection throughout the winter to the eggs. The occurrence of a deutovum stage in the egg is recorded, i. e. the egg has a hard shell which splits into two halves as the contents increase in volume, the lining membrane showing between, and gradually becoming the true exterior envelope of the

* See this Journal, i. (1881) p. 509.

egg. Several new and interesting species were described and figured, and exhibited under Microscopes.

The President said he was very glad that Mr. Michael did not form a new species from a single specimen. The history of the death of the parent insect before the escape of the ova was, he thought, very anomalous in nature; indeed, he did not remember anything at all like it. Many of the Lepidoptera died very soon after the eggs were laid, but he knew of no case in which this remarkable circumstance had been observed.

Mr. Stewart did not remember any in which the eggs were retained in the body of the dead mother, but in the case of the *Coccus* there was something, perhaps, a little like it, the mother dying immediately after the deposition of the eggs, and forming a sort of roof over them with her dead body, which served to protect them during the winter.

Mr. J. W. Stephenson exhibited *Pleurosigma formosum* mounted in a solution of biniodide of mercury and iodide of potassium, a mounting fluid which, with the exception of solution of phosphorus, had a higher refractive index than anything known to him. It had been used by Mr. Browning for prisms, and had an index of 1·68. The index of bisulphide of carbon was 1·624, of monobromide of naphthaline, 1·658, and of sulphur, 1·662, so that the biniodide of mercury was ·056 higher than bisulphide of carbon. Mr. Browning found that the best means of sealing it was by using white wax. He had brought some of it to the meeting as a sample. Being an aqueous fluid appeared to be a great advantage, and it could be used of any strength from 1·33 to 1·68.

The President said he had had his eyes opened to the value of this solution as a highly refractive medium, but had been disappointed by being told that it was only useful for purposes of spectrum analysis, in consequence of the great effect which it had on the red rays.

Mr. Stephenson did not know how far its great dispersive power would be prejudicial, but he had tried it for mounting, and found that it did very well for diatoms.

Mr. Symons read a paper on "A Hot or Cold Stage for the Microscope" (see p. 21), the details of which were drawn upon the board and the apparatus itself exhibited.

The President inquired if Mr. Symons had used this stage for observing the motion of the white blood-corpuscles. He also suggested that the brass would be better if it came rather more flush with the plate.

Mr. Symons had not examined corpuscles with the stage, having hitherto only applied it to ascertaining the melting-points of various substances. He thought there would be no difficulty in using high powers with it, as the objective could be brought into actual contact with the glass if desired, the only thing between the plate and the objective being the thin glass.

The following Instruments, Objects, &c., were exhibited :—

Mr. Crisp :—Parkes's "Drawing-room" Microscope with magnetic stage.

Mr. Deby :—New method of moving the correction-collar of objectives (see p. 107).

Mr. Guimaraens :—Echinorhynchus of *Lota vulgaris.*

Mr. Michael :—*Cepheus ocellatus* n. sp. Nymph—showing the eye-like appearance of the stigmata and stigmatic organs. *Damæus monilipes* n. sp.—showing the tibiæ of the first pair of legs. *Leiosoma palmacinctum*—internymphal ecdysis showing arrangement of the palmate hairs on new skin forming within present one. *Notaspis licnophorus* n. sp.—showing the stigmatic organs.

Mr. Stephenson :—Scales of *Machilis maritimus* and *Tomocertus* (*Podura*) *plumbea*, mounted in phosphorus under $\frac{1}{25}$-inch objective and binocular (see p. 134).

Mr. T. C. White :—New form of Growing or Circulation slide (see p. 19).

New Fellows.—The following were elected *Ordinary* Fellows :—Messrs. William Blackburn, Walter H. Coffin, F.L.S., F.C.S., the Hon. William Nassau Jocelyn, and Theodore Wright.

Conversazione.

The first Conversazione of the Session was held on the 7th December last in the Libraries of King's College.

The following were the objects, &c., exhibited :—

Mr. C. Baker :
- Stephenson's Erecting Binocular Microscope for Laboratory use.
- Homogeneous-immersion and Glycerine-immersion Objectives by Gundlach and Zeiss.
- Abbe's Apertometer and Immersion Illuminator.
- Dissecting Microscope by Zeiss.

Dr. Beale :
- Muscular fibres of the bladder of *Hyla.*
- Nerve-fibres of ditto.
- Capillaries and nerve-fibres of the palate of the common frog.

Messrs. R. and J. Beck :
- *Pleurosigma angulatum* with their new $\frac{1}{6}$ object-glass.

Mr. W. A. Bevington :
- *Isthmia nervosa* in situ.

Mr. W. G. Cocks :
- *Ophrydium* and a remarkably large form of *Epistylis.*

Mr. J. E. Creese :
- Radiolarian ooze from the 'Challenger' Expedition (2600 fathoms).

Mr. Crisp :
- Colouring matter from willow-tree Aphides (*Lachnus viminalis*), polarized, showing the characteristics of Salicine. Prepared by Mr. C. J. Muller in illustration of his paper (*ante*, p. 39).

Mr. T. Curties:
Schizonema Grevillei in situ.
Mr. L. Dreyfus:
Spirorbis nautiloides from a shell.
Professor P. M. Duncan:
Sphœridia from a Spatangoid.
Cliona from a coral.
Mr. F. Enock:
Battledore fly (*Mymar pulchellus*).
Eyes of spider (*Salticus tardigradus*).
Mr. F. Fitch:
Dissection of blow-fly, showing abnormal condition of sucking stomach.
Mr. C. J. Fox:
Various diffraction effects produced by rectilinear and circular gratings.
Mr. D. W. Greenhough:
Crystals of asparagine.
Mr. J. F. Gibson:
Collection of seeds of British flowering plants.
Mr. W. H. Gilburt:
Section of Sporangium of *Equisetum limosum*, showing division of nuclei in spore-mother-cells.
Dr. Heneage Gibbs:
Bacteria in kidney.
Mr. J. W. Groves:
Lymphatics in web of frog's foot injected with silver nitrate.
Transverse section of stem of *Smilax officinalis* stained with magenta, iodine green, and Nicholson's blue.
Mr. A. de Souza Guimaraens:
Diplozoon paradoxum from carp.
Mr. H. F. Hailes:
Dactylopora and other Foraminifera from the Paris basin.
Mr. J. Hood:
Coccochloris cystifera and some Rotifers.
Messrs. Hopkin and Williams:
A large specimen of bichromate of potash crystals (14 lbs.).
Mr. J. Hunter:
Upper and lower jaw of cat, &c., with Polariscope.
Mr. J. E. Ingpen:
Illustrations of Professor Abbe's diffraction experiments.
Mr. W. Joshua:
Desmids of many species from North Wales and other places.
Œdogonium Wolleanum Wittr. β *insigne* Nordst. Stromsberg, Sweden. *Ex Herb. Dr. Otto Nordstedt.*
Œ. Wolleanum Wittr. in Rab. Alg. Eur. No. 2547. Exs. Wittr. & Nordst. Alg. aq. dulc. exsic. fasc. 3, No. 107. This species has its place between *Œ. Borisianum* (Le Cl.) Wittr. and *Œ. concatenatum* (Hass) Wittr., but is well distinguished from both; among other things through the fact that the effect

of the fecundation extends not only to the oosphere but also to the wall of the oogonium. This wall increases in thickness after the fecundation, receiving at the same time longitudinal costæ on its inner side.

Mr. A. D. Michael:

A new species of *Hypopus*.

Eremeus cymba, one of the rarest of the British Oribatidæ.

Dr. Matthews:

Corticium abyssi, and other sponges.

Dr. Millar:

Bacteria which convert nitrites into nitrates.

Mr. Millett:

A species of *Acetabularia* from the Lagunes near Cette.

Mr. E. M. Nelson:

Nobert's 19th band (112,595 lines to the inch), with Powell and Lealand's oil-immersion $\frac{1}{12}$ (N.A. 1·428), and their vertical illuminator (× 1000 diameters).

Pleurosigma formosum, in balsam. Showing the sieve-like structure, with Zeiss's D D ($\frac{1}{6}$) objective (N.A. ·81), and direct light from Powell and Lealand's achromatic condenser (× 950 diameters).

Micrococcus in balsam, showing flagellum (length $\frac{1}{13340}$ of an inch), with Powell and Lealand's oil-immersion $\frac{1}{25}$ (N.A. 1·237), and direct light with achromatic condenser (× 1250 diameters).

Lieut.-Colonel O'Hara:

Crystals in poison of *Bungarus ceruleus*, an Indian snake.

New genus of Homoptera (Colydiidæ) from ant's nest in India.

Messrs. Powell and Lealand:

Amphipleura pellucida in phosphorus, with an oil-immersion $\frac{1}{8}$ (N.A. 1·47).

Mr. B. W. Priest:

Diastopora obelia.

Mr. S. O. Ridley:

Vertical sections of *Halichondria panicea* Johnston (Crumb-of-bread Sponge), prepared by the method adopted by Professor F. E. Schulze for *Euplectella aspergillum* (Trans. R. Soc. Edinburgh, xxix., ii., p. 661).

Mr. J. Smith:

Pleurosigma formosum and *P. angulatum*, with $\frac{1}{16}$ immersion-objective.

Mr. George Smith:

Dolerite from Liassic strata, Portrush, Co. Antrim, &c.

Mr. J. W. Stephenson:

Surirella gemma in phosphorus, with catoptric illuminator and Zeiss' homogeneous $\frac{1}{8}$.

Mr. C. Stewart:

Water spider imbedded in the nacreous layer of an *Anodon*.

Young sole.

Mr. W. H. Symons:
Fatty acids melting and congealing on new hot and cold stage.

Mr. C. Tyler:
Hyalonema mirabilis, &c.

Mr. H. J. Waddington:
Pseudomorphs. Copper. Copper formate reduced by heat. The resulting copper retaining the forms of the original crystals, and analytic crystals of magnesium platino-cyanide polarized with one prism.

Mr. F. H. Ward:
Section of stem of *Nymphæa alba*, *Rosa canina*, *Eucalyptus globulus*, &c., double stained.

Mr. C. White:
Corethra plumicornis.
Pellets of *Melicerta* showing them to be apparently hollow.

Messrs. Watson & Sons:
Pleurosigma formosum with large angle $\frac{1}{4}$, and *P. angulatum* with $\frac{1}{8}$ objective and Crossley's swinging tail-piece Microscope.

Meeting of 11th January, 1882, at King's College, Strand, W.C.
The President (Prof. P. Martin Duncan, F.R.S.) in the Chair.

The Minutes of the meeting of 14th December last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Davies, G. E.—Practical Microscopy, viii. and 335 pp., 1 pl. and 257 figs. (8vo, London, 1882)	*The Author.*
Retzius, G.—Das Gehörorgan der Wirbelthiere. I. Das Gehörorgan der Fische und Amphibien. 222 pp., 35 pls. (Fol. Stockholm, 1881)	*Ditto.*
Micrographic Dictionary, 4th ed., Part 7	*Mr. Van Voorst.*
Eupodiscus argus mounted in gum-juniper	*Mr. F. Kitton.*

The President called the special attention of the meeting to Prof. Retzius' work as one of exceptional excellence, and constituting a very handsome donation.

Mr. Badcock and Mr. Butler were appointed Auditors to audit the Treasurer's accounts.

The List of Fellows to be recommended to the Society for election as Members of the Council at the ensuing annual meeting in February, was read in accordance with the 44th Bye-law.

The President gave notice that at the next meeting an alteration would be proposed in the Bye-law relating to the payment of

subscriptions, so that Fellows elected in any month after February would only be called upon to pay a proportionate part of the subscription.

Mr. Crisp exhibited Beck's Miner's Binocular Microscope, intended for rough use in the field, and a photograph by Mr. Jennings of ·001 grains of arsenic × 400.

Mr. Beck exhibited and described a new achromatic condenser for dry and immersion objectives, with five different front lenses set in a drum capable of being rotated consecutively over the back combination, and giving apertures from 7° in air to 110° in glass (1·25 N.A.). Mr. Beck stated that the mode of setting the front lenses avoided the inconvenience of having the immersion medium drawn away by capillary attraction, as would be the case if the lenses were mounted on a flat surface, as in previous forms.

Mr. Stewart exhibited and described a specimen of Gregarinidæ, from the vesiculæ seminales of the earth-worm, and explained their mode of growth and development, calling attention to the spines frequently observed upon them, and which he inclined to believe were *boná fide* cuticular appendages.

Mr. J. W. Stephenson read a paper "On Mounting Objects in Phosphorus, and in a solution of biniodide of mercury and iodide of potassium," in which he explained in detail the methods which he had found the most successful for the purpose.

Mr. Stewart thought that the biniodide would prove of very great value as a mounting medium, on account of another of its qualities not alluded to in the paper, namely, its chemical properties as an antiseptic. He believed he was correct in saying that it possessed the valuable power of preserving the colours of many delicate vegetable tissues, and that chlorophyll was not changed by it; blues would be found to fade a little, but red was kept well, and he thought that the fluid promised to be of great value in mounting such organisms as desmids, the beauty of which was so greatly increased by seeing them in their natural green colour.

The President said it occurred to him that these fluids might be also of great use in enabling any one to see other difficult objects, such, for instance, as coccoliths; they were very difficult to see in the ordinary way, and he would suggest to Mr. Stephenson to try whether they might not be made out more easily by means of such media as he had described.

Mr. Crisp read a paper "On the conditions for Utilizing the Full Aperture of Wide-angled Immersion Objectives."

Mr. Forrest's Compressorium (received 31st October last and accidentally mislaid) was exhibited and described. It is designed with a view to cheapness, and differs from the Wenham compressorium in the action of the spring and screw being reversed, so that instead of the spring putting on the pressure and the screw releasing it, the screw puts the pressure on and the spring releases it. It is claimed that this in practice will be found an advantage as it enables the observer to feel what pressure is put on.

Mr. Crisp referred to the erroneous statements that had been made as to the supposed advantages of Mauler's blue glass slides in "shortening the wave-lengths and so giving increased resolving power." The fact was that they were intended to be used with objectives affected with chromatic aberration, the performance of which was thereby greatly improved. A letter from M. Mauler was read to the meeting, in which he mentioned that the blue mounts would be found useful in the case of delicate histological preparations. They also agreeably modified the ordinary yellow light of gas and oil lamps.

Mr. Kitton's note on the use of gum-juniper for mounting diatoms was read. It has an index intermediate between water and balsam, and is soluble in methylated spirit. Preparations may be at once transferred from the spirit to the dissolved gum.

Dr. Anthony's paper "On the Threads of Spiders' Webs" was read by Mr. Stewart, enlarged copies of the illustrations being drawn upon the black-board.

The President said that Dr. Anthony had certainly exercised great ingenuity in his methods of procedure. He believed that the nature of the thread depended upon the spinnerets which were used.

Mr. James Smith said that, in watching the process of an attack by a spider upon a fly, he observed that, at the commencement, only two or three spinnerets were used to spin the web round the fly. The first portion of the web was like a quantity of floss silk, and then, as the web converged towards the fly it became more like a gut-line. After a while the fly began to struggle, and then the spider used some more web, and finally used all five spinnerets. He thought, from what he had seen, that the quantity or quality of the web depended upon what the spider wanted to use it for, and, according to this, he used more or less of the spinnerets.

The President inquired whether Dr. Anthony should not have used the word "she" in speaking of the spider. Was it not the female spider which spun the webs?

Mr. Stewart said he had often seen the male spider in the middle of a web waiting for his prey, and always thought it was his own web, for he certainly would not venture into the web of a female, knowing very

well what his fate would be. He believed that the explanation given was quite correct, and that not only were the spinnerets of varied form, but the glands inside them were different in structure so as to be able to produce different kinds of threads. The cross threads, it might be observed, contained an axis of comparatively hard, dry thread, which was exceedingly elastic, and the outside portion was glutinous, like birdlime, and remained so for years. If the thread was stretched this would be seen to be the case; the gelatinous portion would break up into beads.

Mr. Beck said that it was quite easy to examine the different kinds of webs which were spun by a spider, and if they allowed the spider to run out one of the glutinous threads, they could observe the formation of the web and the globules. He had had frequently to use spiders' webs for the cross-lines of transit instruments, for instance, and the kind used were not at all adhesive. Any one who had watched a spider encasing his prey would have noticed how entirely the web seemed to be under command, and that there appeared to be a remarkable power of changing the character of the web at will. The spinning-organs were very highly developed and would form a very good subject for a monograph.

Mr. Crisp referred to the researches of the Rev. H. C. McCook on spiders' webs.*

Dr. Matthews inquired how it was that the spider dropped or divided his web without using his jaws, and how it was that he climbed up his web, if it was composed of glutinous threads?

Mr. Beck said that a spider did not always use glutinous threads. The radial lines of the web were not glutinous; neither were those which were used to tie the web fast to neighbouring objects; but only the transverse lines.

Mr. Michael said that any one who watched a spider, would see that he took great care not to put his foot on the transverse lines of his web; but that in running across it he always walked on the radial lines only.

Mr. Crisp said that in a letter to Mr. Mayall, Dr. Anthony had anticipated Dr. Matthews' query as to the division of the web, and proposed to show in a further communication on the spinnerets that the spider did not use his jaws for the purpose, but that there was a special apparatus at the end of the spinnerets. The diagram accompanying the letter illustrating this apparatus was enlarged upon the black-board by Mr. Stewart.

Mr. Badcock said he had brought some specimens of *Lophopus crystallinus* to show what might be found in the depth of winter. A pond in Epping Forest a few days ago had what looked like a mass of fungi in the middle of it, and on examination it turned out to be an immense quantity of Polyzoa. He thought that naturalists often failed to find things because they did not look for them in the winter.

* See this Journal, ii. (1879) p. 559, and Proc. Acad. Nat. Sci. Phila. 1881.

The pond in question contained nothing of any consequence in the summer.

Mr. Stewart said that the specimen exhibited by Mr. Badcock was the finest he had ever seen.

The following Instruments, Objects, &c., were exhibited:—

Mr. Badcock:—*Lophopus crystallinus.*

Messrs. Beck:—New Condenser (see p. 141).

Mr. Crisp:—(1) Beck's Miner's Binocular Microscope. (2) Photograph by Mr. Jennings of ·001 grain of arsenic × 400. (3) Mauler's blue glass slides.

Mr. Forrest:—New Compressorium.

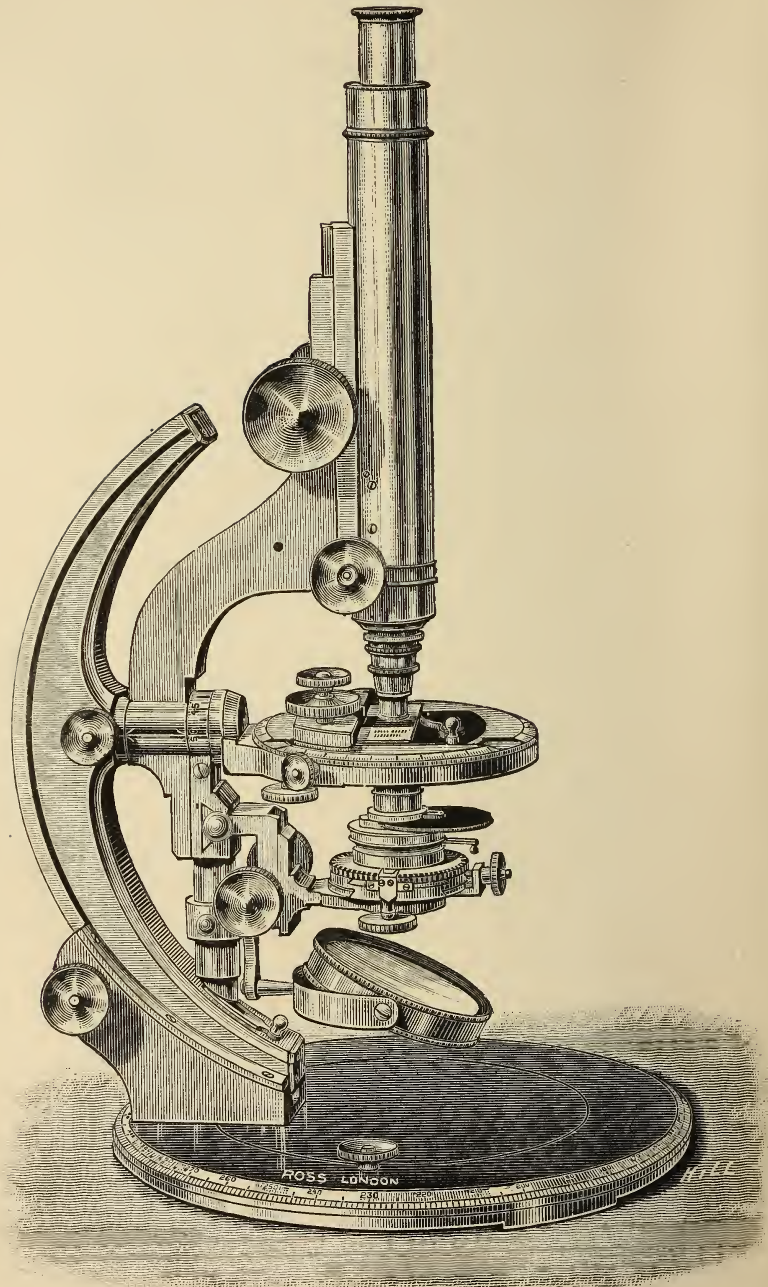
Dr. Gibbes:—(1) *Bacillus anthracis* in lung. (2) Section of tongue treble stained and injected.

Mr. Kitton:—*Eupodiscus argus* mounted in gum-juniper.

Mr. Stephenson:—Specimens illustrating his paper on mounting.

Mr. Stewart:—Gregarinidæ from vesiculæ seminales of the earthworm.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. W. J. Abel, Herbert C. Chadwick, Walter H. Mead, and James Warnock.



Wenham's Universal Inclining and Rotating Microscope.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1882.

TRANSACTIONS OF THE SOCIETY.

IV.—*The President's Address.* By Prof. P. Martin Duncan, M.B. Lond., F.R.S., &c.

(*Annual Meeting, 8th February,* 1882.)

My first and saddest duty in addressing you this evening, is to record the names of those who have passed away from among us during 1881. These are:—C. J. H. Allen, H. H. Bigg, Sir A. Brady, R. C. Griffith, T. E. W. Knight, W. Moginie, E. B. Pitchford, F. Symonds, and J. Tennant.

Of some of these we have not received any obituary notices; those which have been sent to us will be printed in our 'Proceedings.'

While we regret the loss of so many of our Fellows, it is satisfactory to turn to the list of elections into the Society, and to find that, as stated in the Council's Report, we now have more Ordinary Fellows than at any previous period. In 1867 the numbers reached 452, but soon after that date, each year showed a falling off, until in 1878 there were less than 400 Fellows. In the three subsequent years there has been a large increase (after deducting all deaths and retirements), so that the present number is in excess of 500. Whether that total shall be again reduced, depends very much upon the influence which the Fellows may exert upon their friends and others, to induce them to join our ranks. I need hardly say that every addition enables us to increase our usefulness.

The Report of the Council contains an expression of passing regret that the Society is not furnished with the results of more original work on the part of its Fellows. It is, I know, often assumed that we have been worse off in this respect in later years than formerly, but if you will turn to the presidential addresses for 1855 and 1856 * (those of Dr. Carpenter) you will find that he gives expression to the same complaint, and in very strong

* Trans. Micr. Soc. Lond., iii. (1855) pp. 39–40; iv. (1856) pp. 17–21.

terms. Judging from his remarks, I should conclude that so far from having retrograded, we can show a substantial advance. Apart from the valuable papers on the Optics of Microscopy, to which I shall refer more in detail, we have had communications read at our meetings during the past year which were both interesting and important. The description of the beautiful Rotifers *Œcistes Janus* and *Floscularia trifolium*, by Dr. C. T. Hudson; Mr. Michael's description of the singular Acarus *Dermaleichus heteropus*, parasitic on the Cormorant; the notice of the remarkable disks of sulphide of iron found in the London clay and which are pseudomorphs of the silicious tests of *Coscinodisci* and other Diatomaceæ, by Mr. W. H. Shrubsole and Mr. F. Kitton; and the description of a supposed new boring Annelid, *Lithognatha worslei*, by Mr. Stewart, are papers which do credit to the authors.

When we consider, moreover, the large number of observations recorded during the past year by the various Societies which receive communications principally worked out by means of the Microscope, it cannot fail to be recognized that the activity and progress of microscopy are greater now than at any former time, and that the tendency is to still further increase. The most valuable part of our bi-monthly Journal is the summary which it contains of this stupendous amount of original work. The Microscope is moreover always being carried into new fields. It now promises to be of great assistance to the chemist, and while but a few years ago no one thought of including it among the essential tools of the geologist, it is extensively applied at the present time to the examination of rocks, and most valuable results have been brought to light by its aid. Instead then of allowing ourselves to be tempted to bemoan the "stagnation of microscopy" we, as a Society devoted to its study, may congratulate ourselves and the rest of the scientific world, that whether as regards theory or practice—the optical and mechanical or the observational part of our science—there has never been a time when so much evidence could be produced of solid progress as now.

Whilst we can, I think, usefully devote a little time in each year to the consideration of the results obtained in the previous one, it would be difficult within the compass of one annual address to deal with both branches of microscopical work; and therefore (the Society having done me the honour to elect me to the presidential chair for another year) I must reserve for a future occasion a notice of the discoveries in the animal, vegetable, and mineral worlds, which the Microscope has been the means of bringing to light since the commencement of the present decade. The adoption of this course is also supported by the fact, that the past year has been, I think, specially marked out by the important points in microscopical optics, which have, for the first time, been elucidated. In no previous year,

so far as I can gather from a reference to the printed records of the Society, has so much light been thrown upon subjects which are of the first importance in microscopy.

I propose, then, briefly to recall the evidences of progress in this part of our science, which the past year affords.

The Abbe Theory of Microscopical Vision.

As a notable feature may be mentioned the greatly increased interest which has been awakened in the important contribution to the theory of the Microscope, originated by our illustrious Fellow Professor Abbe. Although those views are now several years old, and were brought before the Society so long ago as 1877 by our then Treasurer, Mr. J. W. Stephenson, the recognition of the extraordinary nature of the experiments, was until lately confined to a very small circle. Both in this country and in Germany and America, however, the past year has seen a great extension in the number of those who have followed these experiments, and who have appreciated the important bearing which they have on microscopical vision.

I have used the term "extraordinary" because I think that every one who has seen these experiments will readily agree that it is extraordinary, in every sense of the word, to find, that merely by excluding a greater or less number of the "diffraction" images found at the back of the objective, a great variety of entirely different appearances are presented by one and the same object—lines at a known distance apart doubled and quadrupled,—or that objects in reality quite unlike can be made to seem identical—multi-sided figures giving images of squares. In short, the *same* objects may appear to be *different* in structure and *different* objects may seem to be *identical*, entirely according as their diffraction images are made dissimilar or similar by artificial appliances between the objective and eye-piece. The appearance of particular structure can even be "predicted" by the mathematician, before it has been actually seen by the microscopist.

The result of these experiments is to show that a distinction must be drawn, between the vision of minute objects and what may be termed, for this purpose, "coarse" objects, i. e. those which are considerable multiples of the wave-lengths.

The latter are imaged by the Microscope, substantially in the same way as by the camera or the telescope, and their images correspond point for point with the object. We are therefore able to draw the same inferences as to the actual nature of such objects, as in the case of ordinary vision.

Minute objects, or parts of objects, only a few multiples of the wave-lengths, are, however, imaged in an entirely different way, viz.

by the diffracted rays produced by the action of the minute structure. If *all* the diffracted rays from the object are reunited and reach the eye, an image of the real structure is obtained. If *some* only of the rays are transmitted, the image is no longer necessarily a true representation of the object, and the smaller the admitted portion the more incomplete and dissimilar the image. Now as the objects become more and more minute, the diffracted rays are more widely spread, and fewer of them can be admitted by an objective even of largest aperture. The visible indications of structure in such images are not therefore necessarily conformable to the actual nature of the object under examination, and the only inference that we are entitled to draw from the image as presented to our eye, is the presence, in the object, of some of the many different structural peculiarities which are capable of producing the diffraction phenomena observed in the particular case.

Our veteran microscopist, Dr. Carpenter, C.B., has embodied, in the edition of his widely known work published during 1881, a statement of the leading points of the diffraction theory, which is valuable as containing the results of his own matured views on the subject. He says (p. 187), "This doctrine, originally based on " elaborate theoretical investigations in connection with the undu- " latory theory of light, has been so fully borne out by experimental " inquiries instituted to test it, and is in such complete harmony " with the most certain experiences of microscopists, that its truth " scarcely admits of a doubt."

There are one or two points that require to be kept prominently in mind in regard to the diffraction phenomena in question; 1st, that they are not to be confounded with the so-called "diffraction band" observed round the outlines of objects illuminated by oblique light, nor with the "diffraction" rings displayed by brilliantly illuminated globules; 2nd, that they are not confined to transparent objects illuminated by transmitted light, but are also produced by *opaque* objects; and 3rd, that they are not limited to lined or regular objects, but extend also to *irregular* structures or isolated elements of any shape; in fact universally, to structures of all kinds, whenever the uniform propagation of the luminous waves is disturbed by the interposition either of opaque or semi-opaque elements, or of transparent elements of unequal refraction, which give rise to unequal retardations of the waves. They therefore apply not merely to the "resolving power" of objectives, but to their general *delineating power*—the power of the Microscope to show things "*as they are.*"

The 3rd point is, I need hardly say, most important, and one which it will be very interesting to have more fully elucidated, having regard to Professor Abbe's statement that objects (such as the flagella of Bacteria) which are only a fraction of a wave-length

in diameter, will necessarily appear to us, not in their proper proportions, but with greatly *increased* diameters, and that very minute striations must appear as if the dark and bright interspaces were nearly of *equal* breadth, although in reality not so.

There are obviously many histological problems, such as the question of the structure of muscle, which a proper knowledge of this part of the subject may greatly help to elucidate.

The facts which we now have before us in regard to microscopical vision, are sufficient to justify the injunction of Professor Abbe that "the very first step of every understanding of the Microscope is to abandon the gratuitous assumption of our ancestors that microscopical vision is an imitation of macroscopical, and to become familiar with the idea that it is a thing *sui generis*, in regard to which nothing can be legitimately inferred from the optical phenomena connected with bodies of large size." That there must be a great deal more yet to be elaborated in regard to the origin and nature of the phenomena we have been considering, is obvious, and I hope that the attention of our own physicists and microscopists will be directed to a subject of such extensive practical bearing, not merely to the theoretical microscopist, but to the large class of practical histologists who are entirely dependent upon the Microscope for the accuracy of their observations.

The Aperture of Objectives.

The "aperture question," as we all know, gave rise, several years ago, to a somewhat acrimonious controversy, not in the 'Proceedings' of the Society, but in the unofficial section of its then Journal, and doubtless there were some Fellows who, at the beginning of last year, regarded with no little apprehension the prospect of a revival of that controversy. But, notwithstanding the warmth with which it was debated in its new form, no one will, I am sure, deny the very great value that the renewal of the discussion —between Mr. Crisp and Mr. Shadbolt—has been in bringing to the light what had previously been confined to a few. If any one does not now comprehend how an immersion objective can have an aperture greater than that of a dry objective of 180°, at least it cannot be any longer charged against this Society, that means have not been provided to enable him to do so.

The essential difference between the old and the new view of aperture is simply, that the former considered only the rays which *enter* the objective, while the latter deals with those which *emerge* from it.

The disadvantage of the former method, which estimated the incident pencils entirely by their angles, has been its inevitable tendency to give a fictitious importance to the angle of the entering

pencil, which was supposed to have a special virtue of itself, in the delineation of objects. Naturally, therefore, the same angles, whether in air or any immersion fluid, were considered to produce an equal effect, and the advantage of immersion objectives was rested on minor points.

An estimation of the emergent beam, however, must obviously give the same result as one of the incident beam (assuming them both to be correctly made), it being of course impossible for anything to emerge that has not first been admitted. But to quote Mr. Crisp:—"The great and obvious advantage in dealing with the emergent pencil is that it is always in air, and so the perplexities are eliminated which have enveloped the consideration of the admitted pencil, which may be in air, water, oil, or other substances of various refractive indices." *

The subject of aperture is not, in reality, a difficult one, and any intricacy in which it may seem to be involved will be found to arise from the necessity of clearing away some of the old entanglements, such as the curious mistake involved in the "hemisphere puzzle" and similar matters. Looked at *de novo*, there are two simple stages in the aperture question.

(1) To appreciate that, in using the term "aperture," we use it not in any artificial sense, but as meaning opening and nothing else,—defining, simply, the capacity of an objective for receiving rays from the object and transmitting them to the image.

(2) That the aperture (as so defined) of an objective is determined by the ratio between the diameter of the emergent beam and the focal length of the objective. According as this ratio is greater or less, so the objective will receive and transmit a larger or smaller portion of the total quantity of rays presented to it.

The emergent beam of an air objective of 180° angle cannot exceed in diameter twice the focal length; that of a similar water-immersion objective may be one-third larger, and of an oil-immersion half as large again, and the relative capacities of such objectives (with equal angles) to receive and transmit rays will always be as 1, $1\frac{1}{3}$ and $1\frac{1}{2}$.

It cannot be too carefully borne in mind that it is not a question of this or that theory, but the ordinary laws of geometrical optics which determine that, all other things being equal, one objective will receive and transmit a greater quantity of light than another,

* As pointed out by Mr. J. Mayall, jun., at the commencement of the discussion, if 180° in air is equivalent to 82° in glass, the 140° in glass of the immersion lens must represent something *more*. This fact is, however, so constantly misinterpreted, owing to the supposition that when the immersion fluid is introduced the effect is only that the 82° is no longer compressed by the action of the plane surface of the lens, but is allowed to expand to 140°. This is one only of the apparent difficulties that obscure the proper estimation of the incident pencil, and which are avoided by dealing with the emergent beam.

and therefore has the larger or smaller aperture, according as the diameter of the beam emerging from it is greater or smaller.

As Fellows of this Society we may, I think, be proud of the able communications, relating to this subject, which were published last year in the April and June numbers of the Journal.

Numerical Aperture.

The abandonment of the angular notation for aperture necessarily follows, as soon as the correct view of aperture is appreciated; for when we know that the apertures of three objectives are, for instance, as 98, 126, and 138, no one would insist that they should be designated 157°, 142°, and 130°. A notation can have no title to be considered a scientific one, which denotes things as the same when they are really different (60° in air and oil) or different when they are the same (180° in air and 82° in oil).

Until, however, the "law of aplanatic convergence" had been demonstrated by Professor Abbe, no principle had been established by which the ratio between emergent beam and focal length, could be conveniently denoted.

It would not be possible for me to condense, without a sacrifice of intelligibility, the steps by which he subsequently showed, in a very beautiful manner, that the ratio in question can be expressed by the product of the refractive index of the medium in front of the objective, and the sine of half the angle of aperture, that is by $n \sin u$.

Taking for our *unit* the capacity of an objective for collecting the whole hemisphere of rays from an object in air (i. e. the case of a dry objective of 180° angle) we obtain the "numerical" notation, which commencing with the lowest numbers advances as far as 1·52 with oil-immersion objectives, and by the use of which not only are apertures compared in the same medium, but in different media also, and we see whether they are smaller or larger than the maximum of a dry objective.

It is gratifying to find that the reproach hitherto attaching to microscopists, for the use of a misleading notation, is, thanks to the efforts of this Society, being rapidly removed, and that the initials N.A. are no longer so mystic a symbol as they have been. I understand that many of the opticians have decided to use the numerical notation in the future issues of their catalogues, which is a step in the right direction, which we shall hope to see generally followed.

Whilst on this subject I may point out how important it is that in observations with high-power objectives, their aperture as well as magnifying power should be stated. Whether a large or a small aperture has been used, may make a very material difference in the value to be attached to the results described.

The "Homogeneous Immersion" principle.

The utility of homogeneous-immersion objectives being established beyond doubt by practical experience, it is interesting to note that the origin of the principle is very fully recognized by Professor Abbe to be due to our esteemed Fellow Mr. J. W. Stephenson.

The two essential points in homogeneous immersion are, 1st, the increase in aperture obtained by the use of a fluid of high refractive index and, 2nd, the enhanced optical performance arising from the total suppression of spherical aberration in front of the objective. Professor Abbe states that although Amici first applied oil immersion, he failed to recognize the specific advantage of an immersion fluid being as near as possible in refractive and dispersive powers to the crown glass (i. e. "homogeneous"). He finished his lenses and then sought for oils and mixtures of oils of various refractive powers for obtaining the best correction. "It was Mr. Stephenson who, in his first communications with me, expressed the opinion that doing away with the anterior aberration would improve the defining power, and especially would afford very favourable conditions for further increase of aperture."

The importance of this system will be appreciated when we remember, in regard to the first point (the increase of aperture), that the theoretical resolving power of an objective is thereby raised from 96,400 lines to an inch, which is the maximum of a dry objective, to 146,528 the maximum of an oil-immersion objective, the illuminating power being also increased from 1 to 2·25: while as regards the second point, we are able by the homogeneous-immersion method to reduce the problem of correcting a very wide-angled objective to the much less difficult one of correcting an objective of *moderate air angle.* Our lamented President, the Rev. J. B. Reade, declared in 1870 that "the ghost of aberration will never be entirely exorcised even by cold water." But there appears to be good ground for believing that oil has practically accomplished that object.

During the past year several kinds of fluids for homogeneous immersion have been brought before the Society, such as chloral hydrate and glycerine, iodide of zinc and glycerine, and gum dammar and cedar-oil. Two other vegetable products have also reached us, "tacamaque" and the gum-resin "oliban," or "incense," both dissolved in cedar-oil. While the dammar is claimed to be unchangeable, and to be in refractive and dispersive powers very near that ideal of a good immersion medium, "fluid crown glass," there is evidently room for further research in this direction, particularly for a fluid which will not attack the various varnishes in ordinary use.

Lastly must be noted an important advance in practical manu-

facture by the construction, by Messrs. Powell and Lealand, of a homogeneous-immersion objective of the large aperture of 1·47 N.A. out of a possible 1·52. As long ago as 1850 one of my predecessors in this chair, expressed the belief that objectives had then "nearly, if not quite, attained the limit of perfection," and whilst it will be prudent even at this much later date to avoid any assertion of finality in the present, or scepticism as to the possibilities of the future, it must be admitted that so far as regards aperture and resolving power we have arrived at a point beyond which it will, to all appearances, be difficult to advance, at any rate not without serious restrictions in the use of the objectives. Whilst it might be possible to work front lenses for objectives out of diamond, and so to increase the aperture to 2·5 N.A., and the resolving power to 241,000 lines to the inch, it must be remembered that it would be essential at the same time to provide an immersion fluid, slides, cover-glasses, and illuminators of the same refractive index as diamond also.

Penetrating Power of Objectives—Depth of Vision.

This again is a subject which has long been obscure; very various opinions being held as to the true nature of what has been generally termed the "penetrating power" of an objective. By some it has been declared to be a defect in the construction of the objective—residual uncorrected spherical aberration, in fact; and by others as necessarily inconsistent with perfect definition, even with the best methods of construction; the only approximately correct notion regarding it, being that it decreased as the angle of aperture increased.

Professor Abbe, however, in a very valuable paper, placed the question on the scientific basis so long needed, showing that the total *depth of vision* in the Microscope, i. e. the solid space which at *one* focus of the Microscope is visible with sufficient distinctness, depends not merely on the *depth of focus* of the objective, but is the sum of that and the *depth of accommodation* by the eye.

The depth of focus (other conditions remaining the same) varies in inverse ratio to the magnifying power and also to the numerical aperture of the objective. Thus with a $\frac{1}{4}$-inch and $\frac{1}{8}$-inch of the same aperture the depth of focus of the former would be twice that of the latter, or if the powers are the same but the apertures are ·50 N.A. and 1·50 N.A., it would be as 2 to ·66.

The depth of accommodation depends upon a point which was entirely new to microscopists until developed by Professor Abbe, viz. the peculiar property of microscopical amplification, by virtue of which the linear amplification of the depth of an object is largely exaggerated, being equal to the square of the linear

amplification laterally. Thus an object magnified, according to ordinary parlance, 100 linear diameters (i. e. in breadth) is magnified 10,000 linear diameters in depth. Now the depth of accommodation varies in inverse ratio to this depth-amplification, that is inversely to the square of the magnifying power, so that whilst large with the low powers, it decreases very rapidly and disproportionately as the power is increased.

The joint effect, therefore, of the diminution in the depth of focus and depth of accommodation is that the total depth of microscopical vision diminishes, not in the same ratio as the increase in the magnifying power, but at first in a much greater ratio. With the low powers we have considerable depth of vision, as it is then chiefly influenced by the large accommodation-depth. As we proceed to the medium powers (100–300) the accommodation-depth very rapidly diminishes, and becomes equal to that of the small depth of focus, so that the total depth of vision is necessarily small also. As the power is further increased, the accommodation-depth ceases to have any influence, and the depth of vision becomes principally depth of focus only. If, for instance, an amplification of 30 times is increased to 300, the depth is reduced not to $\frac{1}{10}$ but to only $\frac{1}{50}$ of its original amount; or taking the depth of vision with a power of 10 times to be 2 mm., with powers of 30, 100, 300, 1000, and 3000, it is only ·254, ·0273, ·0047, ·00094, and ·00026 mm.

The formula

$$\text{Depth of vision} = n\left(\frac{L^2}{N^2}\lambda + \frac{L}{N}\frac{\omega}{a}\right)$$

shows at once how much the depth of vision may vary by a change in the conditions—represented by the various factors in the formula —which make up the total effect, important among which, as will be seen from the form of the equation, is the refractive index n of the medium in which the object is mounted.

Micro-Stereoscopic Vision.

The determination of the depth of vision (in monocular observation) naturally throws great light also on the conditions for effective micro-stereoscopic vision. It is obviously only when an object can be completely *seen* in all three dimensions at one adjustment of the focus, that a true stereoscopic image of it can be obtained. So long as only a single layer of inappreciable depth is visible simultaneously with any distinctness, no stereoscopic apparatus, however perfect, can bring into view the form of the whole of the object.

Now with low powers we have large visual depth, so that objects of considerable thickness can be seen as solids. By reason, however,

of the rapid decrease of the depth of vision to which I have referred, the thickness of the objects which can be seen in relief, rapidly and disproportionately decreases as the power is increased, so that only very thin objects are suitable with even the *medium* powers, the absolute depth, in the case of an object magnified 300 times, not amounting to a hundredth of a millimetre. With still higher powers the images of solid objects (though the decrease in depth is no longer so irregular) necessarily approach more and more to simple plane sections, the absolute depth with a power of 1000 times amounting only to a micro-millimetre. For medium and high powers, therefore, the only objects suitable for the stereoscopic binocular, are those which present, within a *small* depth, a sufficiently characteristic structure, that is, which have sufficient salient points for stereoscopic effect. We can, however, increase the depth of vision by using narrow illuminating pencils, and by mounting the objects in some highly refractive substance. The above considerations also show the importance of using the *lowest* power sufficient to recognize the object.

Whilst the reduction in depth limits effective stereoscopic observation, Professor Abbe properly points out that there is a compensating advantage in ordinary microscopic observation, in that as the depth-perspective becomes more flattened the images of different planes stand out from each other with still greater distinctness, so that "with an increase of amplification the Microscope acquires more and more the property of an *optical microtome*, which presents to the observer's eye, sections of the object of a fineness and sharpness that no instrument could produce by mechanical means."

Another novel point was the demonstration of the very material distinction between ordinary stereoscopic vision and that with the Microscope. The perspective shortening of the lines and surfaces by oblique projection, which is an important element of solid vision with the naked eye, is wholly wanting in microscopical vision, in which we have only the other element, a relative displacement of successive layers in the image. That these displacements are seen in the Microscope, depends entirely on the peculiar exaggeration in the amplification of the depth of an object which is not found in ordinary vision.

The paper "On the Conditions of Orthoscopic and Pseudoscopic Effects in the Binocular Microscope" is also a most useful contribution to the theory of micro-stereoscopic vision, establishing as it does the true criteria for both classes of effects, and at the same time clearing up a misconception that had arisen as to the supposed necessity for the rays from the two halves of the objective *crossing* in order to get proper orthoscopic effect. If the delineating pencils have been reflected an *even* number of times in the same plane, the rays must cross, but otherwise not.

Mounting-Media of High Refractive Indices.

To utilize the full benefit of immersion objectives, it is of course essential that the object should be mounted in a medium, the refractive index of which is not less than that of the immersion fluid; and down to a comparatively recent period Canada balsam was most commonly used for this purpose, particularly for diatoms.

Mr. Stephenson, however, pointed out that although by the use of the balsam we have attained our object so far as the aperture is concerned, yet we have done so at the expense of the visibility of the resultant image, which has become fainter by the nearer approximation to equality of the refractive indices of the diatomaceous silex and the balsam; the visibility of minute structures being proportional to the difference between the refractive indices of the object and the medium in which it is mounted. Instead of balsam, therefore, media of high refractive index should be employed; thus, as the refractive indices of diatomaceous silex and Canada balsam are respectively 1·43 and 1·54, the difference ·11 is the measure of the visibility of a diatom in balsam. Using a solution of phosphorus in bisulphide of carbon, the refractive index of which is 2·10, the difference is ·67, and the visibility of the diatoms is now more than six times as great as it was in the balsam.

Continuing his researches on this subject, and endeavouring to find the best media with high refractive indices, he has quite lately brought before the Society the utility of an *aqueous* fluid capable of being given the high refractive index of 1·68, viz. a solution of biniodide of mercury and iodide of potassium in distilled water. This more manageable and highly antiseptic medium appears likely to turn out to be of great use in the observation of many objects, as its strength can be diluted till the index of water is obtained. This is of advantage with such objects as muscular fibre, which are themselves of high refractive power, so that fluids of *low* refractive power must be made use of to obtain the required difference for more perfect visibility. The same communication also contains what was much wanted, detailed practical directions for mounting.

Any one who has seen the diatoms and scales mounted in phosphorus by Mr. Stephenson's method, and exhibited at our meetings during the past and present sessions, cannot fail to have been struck by the great increase in their visibility as compared with those mounted in balsam. or to have recognized the fact, that the theoretical consideration by which their visibility was pronounced to be much increased, was not unfounded.

In addition to the increase in visibility, there is also the fact

that by means of such mounting fluids, the capacity of stereoscopic binoculars with the higher powers is considerably enhanced. True stereoscopic effect, as we have seen, requires a depth of vision not less than the thickness of the object under observation — a depth which, as already shown, increases in direct proportion with the increase in the refractive index (n) of the mounting fluid. If one object is in air when $n = 1 \cdot 0$, whilst another is in a solution of phosphorus, where $n = 2 \cdot 1$, the depth of vision will be more than doubled. Objects, therefore, that by reason of their thickness could only afford an unsatisfactory stereoscopic effect in air may be seen in full relief when mounted in phosphorus.

Here, again, the deductions of theory were remarkably verified by the recent exhibition of *Surirella gemma*, under the binocular, with a $\frac{1}{25}$-inch objective.

Relative Value of Objectives with Large and Small Apertures. ("*All-round Vision*").

I now come to a much-vexed question, that of the relative value, practically, of objectives of large and small apertures, in regard to which a great variety of opinions have been promulgated.

The oldest of these views was that which made the preference between the two kinds of objectives, depend upon whether they were to be used for the "ordinary purposes of the biologist," or for the examination of diatoms or other lined objects. The objection to this view is, that it assumes the only function of a large aperture to be its resolving power, a much too restricted notion, and one which deprives the working biologist of a most essential aid to his observations upon structure.

A more modern view errs in the opposite direction, and insists upon the universal superiority of large apertures, so that work done with small apertures will "have to be done over again."

There is again a third view, still more recently put forward, which goes much further than the preceding, and according to which it is impossible that wide apertures can give correct images. First on account of the unnatural "all-round vision" which it is contended is obtained with them, and secondly by reason of their supposed inherent defect in defining power, in consequence of the dissimilar images presented by the different parts of the enlarged area of the objective, with a confused image as the general resultant.

The want of exactness in the first two suggestions will sufficiently appear, when we have formulated the grounds upon which large apertures are shown to be indispensable for all observations upon minute structure for which high powers are necessary; but it will be desirable first to point out the erroneous interpretations upon

which the third view (as to all-round vision and dissimilar images) has been founded, and for this purpose it will be necessary to refer to the paper by Dr. Royston-Pigott, F.R.S., in which the subject is dealt with.*

After reminding his readers that he had shown that spider-lines, miniatured down to the fourteenth part of the hundred-thousandth of an inch, were distinctly visible to ordinary good eye-sight under proper microscopical manipulation (an experiment which, I may remark in passing, has not a satisfactory foundation), Dr. Pigott says:—"Under these circumstances it was interesting to know whether real objects could be detected by the Microscope in the surprising degree of attenuation represented by the millionth." Minute particles of mercury were obtained by smashing some with a watch-spring, and they were mounted in petroleum under a thin cover. A vertical illuminator was used to converge rays downwards, through the objective, upon the preparation. In a darkened room minute disks became visible, and upon some of them clusters of minute black points were seen with a power of 1000 diameters. Comparing them with a micrometer spider-line $\frac{1}{10000}$ inch diameter, some of the points were found to be decidedly smaller. Under 1000 diameters the particle was magnified one hundred times in the micrometric focus, and then appeared less than the spider-line. Its real diameter was therefore less than $\frac{1}{100}$ of $\frac{1}{10000}$ inch, or less than the millionth of an inch, and the writer draws the conclusion that "real objects of unsuspected minuteness may be microscopically displayed as well as minute miniature images." To this part of Dr. Pigott's observations it may be pointed out that it has never been supposed, so far as I am aware, that there is any limit of *visibility* in the Microscope other than that imposed by the sensibility of the observer's retina, the correction of the objective, and the illumination. The question of a limit of visibility is quite distinct from that of a limit of separation, just as in telescopic vision a single star is always visible, however small its visual angle, provided it is sufficiently *bright*, but a double-star requires a certain minimum aperture of the objective, dependent on the angular distance of both stars.

Discussing the variability of the blackness and thickness of the marginal annulus of refracting molecules, as exemplified in a glass spherule ·1 inch diameter, and in the featherlets of the death's-head moth and plumelets of *Hipparchus Janira* with objectives of 20° Ang. Ap. power 200, and 140° Ang. Ap. power 800, he writes:—"If then the minute fibrillæ of the plume can be clearly distinguished as closely packed black lines at a visual angle of 20 seconds with a low aperture of 20°, this result is fatally opposed to the popular idea that very close lines, or very minute lines or bodies, can only be distinguished with large angular aperture.

* Proc. Roy. Soc., xxxi. (1881) pp. 260-78.

These lines were most sharply seen though less than $\frac{1}{80000}$ inch thick." After noting the disappearance of distinctive shadows and consequent obliteration of structural molecules with excessive angular aperture, illustrating his meaning by the structure of Podura scales, with different stops and under very varying conditions, Dr. Pigott states that he has come to the conclusion that residuary aberration was not the only cause of the obstinate obscuration of minute crowded molecules in translucent organic forms, but that

> "Excessive angular aperture, he found, attenuated margin. . . . There is, it may be said, something unnatural in the mode of vision intrinsic to very high angled glasses. It is undoubtedly true that such a glass presents an *all-round vision.* It really conveys visual rays from a given brilliant particle, at every inclination in azimuth and altitude, and this too at one and the same instant. To illustrate this position a minute die may be imagined the $\frac{1}{1000000}$ inch broad. The highest angled objective really enables the observer to collect rays emanating from *four sides* and the top at the same instant. The human eye could at most view *three sides* at once. Doubtless the effect of this angular vision all round the corners, causes particles to look spherical, when sufficiently minute, even if cubical."

Now it is necessary to say plainly that this view is founded upon a fundamental error, "belonging," to use Professor Abbe's words, "to the venerable relics of the past *naïve* period of microscopical science, which was characterized by an unshaken conviction in the validity of the hypothesis that microscopical vision is in all essential respects the same thing as ordinary vision." The "all-round vision," by virtue of which we are supposed, when looking at a minute cube, to see at the same time the top and all the sides (with the result of rounding off the corners and angles!), does not really exist, as can be shown by the application of the simplest laws of *geometrical* image formation. The different obliquities of the rays in an objective of wide aperture cannot give rise to any all-round vision, for in the Microscope there is no difference of *perspective* attendant upon oblique vision as with the naked eye. The difference of *projection* of successive layers which exists is ineffective, except in the case of binocular vision. This absence of perspective may be readily established by examining an object alternately by an axial and an oblique ray; it will be found that there is no shortening of the lines in the latter case, and no capacity in the Microscope, therefore, for "all-round vision." Indeed if this theory were correct, microscopical vision, even of *plane* objects and with very moderate apertures, would be entirely destroyed.

Equally mistaken is the second branch of the view which I am considering, viz. that a wide aperture must, in the nature of

things, impair definition on account of the increase, thereby produced, in the dissimilar images received through the several parts of the objective. In support of this view, illustrations drawn from stereoscopic vision are adduced, which admittedly does depend upon the dissimilar images formed by the right and left hand halves of the objective; but, as Professor Abbe has shown, the dissimilarity of images presented by an objective of wide aperture is a dissimilarity in the projection of *successive layers* only, and this is *not effective* unless we produce these images by different portions of the aperture *separately and conduct them to different eyes*, as in binocular Microscopes. The sole effect of the wider aperture when the images are not so separated, is a reduction in the depth of vision—to confine us to the vision of thinner objects, not to impair the definition of what is seen when the objects *are* within the range of penetration.

If we pass to practical experience, we shall find that the principles which theory establishes are amply confirmed. All who have worked with wide-angled objectives cannot fail to have recognized the great fact of modern practical optics, the perfection of definition obtained with such glasses—a fact which has been verified by such authorities as Mr. Dallinger, who, so long ago as 1878, stated of a new $\frac{1}{8}$-inch homogeneous-immersion objective of the wide aperture of 1·25 that "the sharpness and brilliancy of the definition which this lens yields is absolutely unsurpassed in my experience."

The question of the power of resolution supposed to be possessed by small apertures can also be brought to a very simple practical test by those who believe in that view exhibiting here to the appreciative assemblage which they would have around them, say 75,000 lines to an inch resolved with the low apertures referred to!

We have seen that on the one hand the depth of vision decreases as the aperture is increased, and that on the other as the objects become smaller and smaller the similarity of their images increases with the increase in the aperture—the one representing a disadvantage attendant upon large aperture and the other an advantage—and bearing this in mind we are in a position to arrive at a correct view of the relative value of objectives with large and small apertures, which I take to be this:—

Both kinds of objectives are necessary for investigations into the structure of *minute* objects, and an observer to be fully equipped, should provide himself with *two* objectives, one of moderate and one of wide aperture. The former would be used for the more general survey of the various parts of the object, and the latter for the subsequent examination of its minute structure. In searching, for instance, through a stratum of fluid

for Bacteria a wide aperture would be unnecessary, but when a particular Bacterium is found, it is only that which will give us an accurate view of its flagellum.

But again, in the choice of the objectives, the *proper relation between magnifying power and aperture* must be maintained. For work with low powers, it is useless to have large apertures. The structure of the objects for which such powers would be used is not sufficiently minute to require large apertures for their proper delineation, and we therefore expose ourselves to the disadvantage of very restricted penetration and the trouble of delicate manipulation, without any corresponding benefit.

On the other hand, it is equally useless to work with high powers (that is upon minute objects) with small apertures. We should have only an empty amplification—mere increase in the distance apart of the outlines, without any additional structure being made visible in consequence of the defect in aperture.

Whenever the subjects of our examination are so minute as to *require* high amplifications in order to be seen, then we must also have large apertures in order to obtain perfect delineation of the objects.

Leaving now the theoretical questions, which after all have so important a bearing on our practical work, reference only need be made to the descriptions published in our Journal of new inventions in regard to mechanical and optical appliances (most of which have been exhibited at our meetings) to prove that great progress is being made in the designing, manufacture, and application of the Microscope. Improved stands and eye-pieces, new immersion lenses, stages, and swinging substages, more effective fine movements and elaborate accessory apparatus of all kinds, indicate not only the activity of mind and the abundance of the resources of the microscopical optician, but that these things are really required in a progressive science.

It is to be hoped that the possession of excellent instruments and convenient apparatus will incite many of the Fellows to undertake more careful researches into the minute details of organic nature, or amongst the very fascinating rocks which are being so beautifully cut and mounted by petrologists. It is true that the difficulty of getting upon a path of original research is very deterrent. The activity of Continental and American microscopists is indeed great, and it is always necessary, before committing oneself to any statement, to search and prove its originality. Much microscopical research is quite beyond the powers of the man who has other avocations, and to whom the instrument is a pleasing, and none the less important, toy. Consider the paraphernalia required to study the microscopy of the details of a minute animal.

It has to be put into hardening and water-absorbing solutions, then to be cut with microtomes, perhaps frozen in the first instance, then to be put into other solutions to be cleared and to have its fat got rid of, and then it has to be coloured once, twice, or thrice, and possibly to have some colour discharged. Finally it has to be mounted in a medium. It is necessarily somewhat deterrent for a modest microscopist to read the excessively pronounced opinions of manipulators, about the nature of the structure they discover in such complicated and altered organic matter, and to find that very contradictory opinions are published by different investigators about the nature of identical structures which have been differently prepared. It appears to many an amateur, who happens to investigate structures by disturbing their natural condition as little as is possible, that he is, as it were, out of the field. He may find it necessary, even in examining the simplest section, to pay especial care to the illumination and centering, and to the application of particular powers. He is, of course, conscious of inferiority, when he knows that somebody merely puts a chemically treated specimen under an objective without the least care about optics, and finds out, or thinks he finds out, the truth. But there are numerous opportunities for original research still to be met with in the structure of many of the commonest invertebrates and plants. The study of rocks is in its infancy, and there are many very interesting physical questions yet to be determined, and which can only be settled microscopically. Recondite manipulation is not much required in any of these researches, but rather a good knowledge of how to use the Microscope as an instrument.

If in any case there are obstacles to original research, it is always interesting to follow the work of some distinguished investigator. It is very rarely that a subject is treated exhaustively, and the sedulous yet candid critic, may solve truths which his predecessor had not approached.

In concluding this address, I cannot avoid a special mention of the recent death of a man whose genius and careful microscopical work, established an era in histology, and influenced that study of embryology which must ever be the starting point of philosophical zoology and botany. Theodore Schwann elaborated the "cell theory" forty-three years ago, and in the main it holds good at the present day. He lived to see its value appreciated by every zoologist, and to be able to follow the researches with improved lenses, and to recognize the entities which have no cell-wall. Schwann investigated most successfully the nervous system, and his name will ever remain associated with it. He died at a ripe old age, having led an industrious, simple, and most useful life, and having lived to see himself the recipient, on the occasion of his jubilee, of distinguished honours on the part of the scientific world.

V.—*On Mounting Objects in Phosphorus, and in a Solution of Biniodide of Mercury and Iodide of Potassium.* By John Ware Stephenson, Vice-President R.M.S., F.R.A.S.

(*Read* 11*th January*, 1882.)

In the use of modern objectives having numerical apertures exceeding *unity*, or, in other words, exceeding the equivalent of 180° in air, it is absolutely essential, and this cannot be too strongly impressed, that the refractive index of the medium in which an object is mounted, shall at least equal the numerical aperture of the objective employed.

Hence it follows that air, having a refractive index of 1, is not a suitable medium in which to examine an object under an objective of which the numerical aperture is more than 1, say 1·25, or 1·47; the former being that of the first homogeneous immersion objective (made by Zeiss), and the latter that of the most recent production of Powell and Lealand.

For instance, water, having an index of 1·333, is a medium of sufficient power to develope the full aperture of the objective of N. A. 1·25; whilst Canada balsam, or any other medium having a refractive index exceeding 1·47, is necessary for the latter.

An object is literally mounted in air, only if a film of air intervene between it and the thin glass cover. If it adhere to the cover, the effect is the same as if it were half in air and half in glass, and if the aperture of the objective exceed unity, its effective aperture is reduced from a, to $\frac{1+a}{2}$, that is to say, one-half of the excess of aperture beyond unity, is, under these particular circumstances, entirely lost.

The problem then is, in all cases, to find some medium fulfilling the before-mentioned conditions, but at the same time such, that the difference in the refractive indices of the object and medium shall form a sufficiently strong image to give distinct vision, but on the other hand not so great as to render the object opaque.

In some preparations, however, the end in view is to render certain parts of the object very faintly visible, in order that other parts may become more visible by contrast. This is notably the case in preparations which have been injected or stained with some pigment, when colour alone is depended upon to depict the structure. We all know that such an object in spirit or water or alcohol is frequently too opaque for our purpose; the difference in the refractive indices of the material to be examined and medium employed is too great, and we, therefore, "*clear the object*," as it is called, by transferring it from pure spirit, with its low refractile

power, to the higher one of oil of cloves, and finally into balsam; by so doing we have placed the object in a medium approximately of the same index as itself, we have optically got rid of the unstained portions, leaving the coloured parts more distinctly visible.

Muscular fibre is an illustration of the effect produced on the visibility of an object under these conditions. In water or glycerine (optically considered) it is well shown, because the difference of refractile power is sufficient to depict the structure and not so great as to obscure the view; but mounted in Canada balsam, in which the two indices are so much nearer equality (balsam being less than the muscular fibre), the image is so faint that we resort to polarized light, if it be necessary to examine it under such circumstances.

This, however, is a digression from the original scope of my observations, which were rather directed to the question of mounting when modern objectives of large aperture are employed.

I have pointed out that if an object adhere to the cover the utilized aperture is reduced to $\frac{1 + a}{2}$; but if it be mounted on the glass slip it is, for the purpose of our investigation, in the worst possible condition, as the effective aperture is reduced to something less than the equivalent 180° in air—very little less, it may be perhaps, but still, if a film of air intervene, its available aperture cannot be quite up to this limit.

If Nobert's 19th band were ruled on the slide, instead of on the cover, or, what is the same thing, if the plate were turned over and covered with a thin glass, so that a film of air, however thin, intervened, no objective that has ever been made, or I may say ever will be made, would be capable of making the lines *visible.*

The result would be vastly different, however, if Nobert's plate were mounted in some medium giving a difference of index sufficient to render the rulings visible; such a medium is a saturated solution of phosphorus in bisulphide of carbon; here the respective indices of the object and medium are, (if Nobert's lines are ruled on crown glass), about 1·52 and 2·1; the difference between these gives a greater degree of visibility than that of a diatom in air, the difference of the former being 0·58, and of the latter about 0·43.

So mounted, the resolving power on such rulings would be increased by more than 11 per cent. with the first homogeneous-immersion objective, and by more than 19 per cent. with Powell and Lealand's more recent production, so that the 19th band by no means represents the attainable limit of resolution, if such rulings are suitably mounted.

In mounting objects in phosphorus there are three points of vital importance:—

1. The object must be absolutely dry, or if moistened, it must be with a substance soluble in bisulphide of carbon.

2. The phosphorus must be introduced with the least possible exposure to the air, as phosphoric acid is otherwise very readily formed, and this ruins the preparation.

3. The solution of phosphorus must be perfectly clear and bright.

Of not much less importance is the necessity of having a vessel of water at hand, in order that the bibulous paper which has been used in the process, may be instantly submerged so as to prevent the danger of spontaneous combustion, and also to avoid the inhalation of fumes from the phosphorus which are prejudicial to health.

In the preparation of the solution a 2-drachm bottle without any contraction for the neck is employed. A filter of bibulous paper is formed, accurately to fit the bottle by folding the paper down and around a small ruler or other cylinder of wood, of such a size, that with the paper around it, it may fit tightly into the bottle, to the bottom of which it is forced, and the wood withdrawn. The filter is now moistened with a few drops of bisulphide of carbon, all excess beyond that which is necessary for this purpose being dashed out, and a piece of stick phosphorus, as pure as possible, and say $\frac{1}{4}$ or $\frac{3}{8}$ of an inch in length, dropped into the filter, and the bottle corked; the vapour from the bisulphide instantly acts upon the phosphorus, and in about half an hour or less it will be entirely dissolved, but still remaining in the filter. By taking a firm hold of the edge of the filter with a pair of forceps, and very slowly drawing it upwards, a partial vacuum is formed beneath the filter, and the pressure of the atmosphere on the surface of the solution forces the phosphorus through the paper, and the brilliant highly refracting fluid is seen at the bottom of the bottle. The filter now withdrawn must be instantly plunged in water for reasons already given.

The phosphorus being thus prepared, the mode of mounting is as follows. We will suppose the object to be diatoms, and of course adhering to the cover.

In the first place a ring, somewhat smaller than the thin glass cover, is formed on the slide in the usual way, using for the purpose a solution made of glue, mixed with a small quantity of honey, which preparation when cold should form a somewhat stiff jelly.

The thin cover is now placed on the glass slip, but being raised on one side by a piece of bristle or fine wire, it is only the opposite side which touches the glutinous ring, to which it adheres. The reason for tilting the cover will be seen hereafter.

The next step is the real mounting, which is effected by means of a pipette; this is made of glass tubing (say $\frac{1}{8}$ of an inch in external diameter); drawn out to a fine point at one end, the other

more open end being capped with about an inch of indiarubber tubing, whipped on to make the joint air-tight, and the free end closed by a clump or plug or by any other means.

The pipette thus made is passed through a cork, so that the fine opening formed at the pointed end shall reach the bottom of the bottle or nearly so, and will therefore be beneath the surface of the phosphorus.

The indiarubber tube being squeezed, forces out some of the air contained in the pipette, and on relaxation of the pressure, the partial vacuum thus formed is occupied by a drop or perhaps two of the phosphorus.

The fine point of the pipette, which will generally be found free from any adhering phosphorus, is now introduced beneath, or close to, the edge of the tilted cover. The tube is squeezed, and the phosphorus thus forced beneath the cover instantly fills up the space between it and the slide. It will not fail to be observed that the whole aim has been to expose the minimum surface of phosphorus to the oxygen of the atmosphere; if phosphoric acid is formed, either by fuming and condensation on the thin cover, or on the exposed surface of the phosphorus the object will, as previously stated, be spoilt. Should this operation have been successfully accomplished—and there is no difficulty in doing it—all risk is over; the cover is gently pressed down and the mount closed by passing some of the warm preparation of glue around it.

When this has set pretty securely, which will be in about half an hour, it will probably be found that some of the redundant phosphorus has escaped from beneath the cover; this is conveniently removed by a piece of blotting paper wetted with bisulphide of carbon; it must be applied with a pair of forceps, special care being taken not to touch the paper so used with the fingers, and it must be plunged into water immediately after using, as it will otherwise take fire spontaneously, at ordinary temperatures, in the course of a minute or two. Phosphorus left in contact with glass does not appear to do this; at the same time it must not be forgotten that noxious fumes are always given off by phosphorus when exposed to the air, and it ought therefore to be removed.

As it is possible, notwithstanding every precaution, that some phosphorus may accidentally get on the fingers, it is desirable to have a small quantity of olive oil, as well as an oiled rag close at hand. Phosphorus is very soluble in olive oil, and as the solution is incombustible (spontaneously) an instant application removes the danger. It may seem that this risk has been too much dwelt upon, but as a burn from phosphorus is frequently very severe, it does not appear to the writer to be inopportune to urge the point. The slides may now be put aside for a day or two, when they can be

finally completed by two or three successive coatings of gold size, after the first of which, any superfluous glue should be removed with water and a camel-hair brush, and "to make assurance doubly sure" a ring of sealing-wax (shellac) varnish after the last coating of gold size may well be added.

The slides thus prepared appear to keep perfectly well, as one of *P. formosum* which I mounted nine years ago and exhibited here on the 4th June, 1873, still remains unchanged; but it is fair to say, that having been during that period in my cabinet, it has had little exposure to daylight.

In addition to the increase of visibility there is another point of interest in the use of phosphorus. It was pointed out by Professor Abbe in our last volume, pp. 689 and 832, that depth of vision $= n\left(\frac{L^2}{N^2}\lambda + \frac{L}{N}\frac{\omega}{a}\right)$, from which formula it is obvious that the depth of vision (on which stereoscopic vision depends) increases in the same ratio as the refractive index (n) of the mounting medium. Hence it follows that the stereoscopic effect of phosphorus, with its index of $2 \cdot 1$, is more than double that of the same object mounted in air ($n = 1$), and it is to this circumstance that the stereoscopic appearance of the scales of *Machilis maritimus* and *Tomocerus plumbeus* under a $\frac{1}{25}$ is to a great extent due.

There is now another fluid to which it is very desirable I should again draw attention, and that is a solution of biniodide of mercury and iodide of potassium in distilled water. This is very easily prepared by adding the two salts to the water until each shall be in excess; when this point of saturation has been reached the liquid will be found to have a refractive index of $1 \cdot 68$, by far the highest aqueous solution known to me. With this fluid there is no difficulty or danger (apart from its poisonous nature) whatever, either in mounting or preparing. Its advantages from an optical point of view are considerable, and it may be used of any strength: commencing with pure water, with a refractive index of $1 \cdot 33$, we can go on progressively to $1 \cdot 465$, which represents glycerine, still on to $1 \cdot 54$ (Canada balsam), again onwards to $1 \cdot 624$, which represents bisulphide of carbon, to $1 \cdot 658$ which represents the monobromide of naphthaline, to $1 \cdot 662$ the equivalent of a solution of sulphur in bisulphide of carbon, until, undiluted, it finally reaches its own maximum of $1 \cdot 680$;—thus we have the representatives of all these media and an infinite number of others in this one fluid.

As mentioned at our last meeting, it is easily sealed with white wax, and I have found the following a simple and effective plan of doing so.

The glass slip having been heated on the turntable, a wax cell is formed by touching its surface with a piece of white wax; in the

centre of the circle thus formed, when cold, a drop of the solution is placed, and on this the thin glass cover.

The cover can be fixed by heating an ordinary gun-punch (or other metallic ring) to the melting-point of wax, and placing the cutting edge on its upper surface; the weight of the punch as the wax melts soon adjusts the cover in its place, and when cold the excluded solution is cleaned off.

Two or three coatings of gold size and one of shellac finally fix it, as in the case of the phosphorus.

This fluid is so dense, its specific gravity being 3·02 (as kindly determined for me by Mr. C. G. Stewart, of St. Thomas's Hospital), that almost any microscopic object will float on its surface; this is the case with diatoms, for example, and consequently any which may become detached will still be found in contact with the cover, and may thus possibly present themselves under different aspects.

Its refractive index being 1·68, the visibility of diatoms, when mounted in it, is represented by the number 25 as compared with 11 in Canada balsam—in other words the image is nearly $2\frac{1}{2}$ times as strong; this is no doubt very inferior to that yielded by phosphorus, in which the strength of the image is 6 times as great as in balsam, but nevertheless, *Amphipleura pellucida* is very easily resolved in it, and on looking over a slide, mounted last evening, not one valve was found (and they were delicately marked), which was not resolved without any trouble under Zeiss' homogeneous $\frac{1}{8}$.

For muscular fibre, on the other hand, a strong solution is not suitable, since the high refractive power of the object approaches that of the medium, and the resulting image is consequently very faint, but as every other medium of a lower index than 1·68 can, by dilution, be represented by it, any degree of visibility down to that yielded by water can be obtained.

For marine animals a weak solution is probably well adapted, as about a 1 per cent. solution (5 minims to the ounce) will give the specific gravity of sea-water, with no appreciable difference in the refractive index; and the same strength appears suitable for some vegetables. How far the colours of these may fade can only be determined by time, but a limited experience shows that the colouring matter of the petals of flowers is dissolved out, although the action on chlorophyll appears in some cases to be small, after two or three weeks' exposure.

Although the dispersive power of a mounting medium is not of importance, it may be mentioned as a matter of interest, that the dispersive power of this fluid is excessively great, being equal to 0·05483 (that of very dense flint glass, $n = 1·802$, being only 0·03287), and the extension of the blue in comparison with the red, much greater than that of any other known substance, as I am

informed by Professor Abbe, who kindly determined these points with his Refractometer from a sample sent by me for his examination.

Being an aqueous and highly antiseptic fluid, no transfer from it to another medium is required, but I am unable to say what its effect may be on stained preparations, possibly unfavourable, but on this point as well as on its chemical effect on different structures I am unable to express an opinion at present. On the whole, however, I venture to think that for the above and other reasons it is destined to become of great importance in the microscopy of the future.

VI.—*On the Threads of Spiders' Webs.*

By John Anthony, M.D., F.R.M.S., &c.

(*Read* 11*th January*, 1882.)

In the course of observations on the habits of spiders, and more particularly of those which construct geometrical webs, an idea occurred, that by management, the *Epeira Diadema*—one of the largest of our garden spiders—could be made to spin his thread in such a way, as to cause the whole, or the greater part of the strands composing this minute cord or cable, to remain separate, instead of coalescing, and so forming the well-known "thread" by which the diadem garden spider is so often seen suspended. The experiment answered perfectly, and the results were so full of interest for the student of natural history, as to cause me to describe carefully the means I employed, so that any one may be able to repeat the experiment, and arrange fairly permanent preparations of the parts making up the spider's thread for deliberate examination under the Microscope; premising, that so far as is known, the same method will be equally successful with any of the web-spinning spiders.

A fine *Epeira Diadema*, suspended as usual by his thread, being available, six ordinary slips of microscopic glass were placed in readiness to have the spider's thread wound upon them as it was spun. The idea acted on was, that the threads issuing from the hundreds of "spinning-tubes" on the various papillæ or teats, known as "spinnerets," *must* travel for an appreciable distance ere they coalesced in a more or less hardened but still glutinous condition, to make up what we call in popular language "the spider's thread," and that, therefore, these ultimate fibrils, though numbered by hundreds, and of exquisite fineness, could assuredly be intercepted at a point sufficiently near the spinnerets to cause the strands to remain separate on the surface of the glass slip, instead of coalescing. The slip was then made to catch the Epeira thread, winding the line so as to come near the body of the spider, who not liking the look of things, lowered himself, as was expected, rapidly towards the ground to escape, and was as rapidly wound up, and raised into mid-air.

Now, as spiders do not like to part with spinning material if they can avoid it, and as Epeira evidently got no nearer the ground, he paused in his "paying out" of line to think a little, and he did not cut his thread, inasmuch as a fall from that height was not to be risked; so, as he was now pretty steady, another slip was brought into operation, the edge of it placed close under the spinnerets, or in the actual position of the spider, rather above them, and once having got adhesion of these issuing strands while they were quite separate, it was manifest that with due precaution in winding up,

the strands need not be allowed to approximate to form the rope; so wind after wind, the exquisitely delicate floss-silk-like strands were stretched over the surface of the glass slip—evident to the naked eye by an iridescent appearance. These strands being directly across the slip at right angles to its long axis, would be very close together, even if not often touching each other, so on another slip a variation was made, by tilting the slip sideways as it was turned to receive the strands; the brush of minute filaments, which had a tendency to approximate, was now made to diverge, and spread out on the surface of the slip into a sort of fan-shape, and this arrangement may be seen on the slide under the Microscope. From the very small portion visible under a magnifying power, the effect is, that the minute filaments are parallel, like harp-strings, to which they bear no small resemblance, but inspection will show that this mass of filaments has by the device named been rendered divergent.

There was now no difficulty in covering all the remaining slips with these separated components of the spider's thread, and, as might be expected, these slips showed, on after examination under the Microscope, every variety of combination by which the infinitely small filaments combined to make up a manifestly substantial cable; so that, taking the number of teats bearing the ordinary spinning-tubes to be four, there would be seen the four strands making up the cable, and in another part the ultimate filaments of which these strands were composed.

I am glad all these things can be shown on the slip under the Microscope; they look exquisitely beautiful by any mode of lighting, but under dark-ground illumination, the effect of hundreds of silver wires of marvellous delicacy is charming beyond expression.

It may be stated that at the end of the experiment, Epeira, whose patience had been rather severely taxed, was let down near to the ground, when, the haste with which he severed his thread and scampered off, was evidence that his quietude in mid-air was more a matter of prudence than inclination.

An identical mode of obtaining a division of the thread was employed in the case of a very small spider which has the habit of lowering itself from ceilings, the trivial name of which is "Money Spider." The results obtained were very similar, the thread was seen divided into its component parts, but how many parts it would be difficult to say, for the difficulty now became to find these ultimate filaments; it was evident that they were there, but so fine as to require a careful illumination and a fine high-power objective, with very careful touches of the "fine adjustment," to make them out, and then they looked very much like very finely ruled micrometer lines irregularly spaced.

It is rather important to notice one portion of the conclusions

arrived at from these experiments, and that is, that in reckoning up the number of filaments spun by Diadema, and going to make up the cable, the count always came below 200. Now this would appear quite insufficient as a product of the spinning-tubes, which in a fine preparation I have of the spinnerets by Bourgogne, certainly exceed 1000 in number; so it would seem we have to fall back upon the conclusion, that either all the spinnerets are not in action at the same time, or, that a considerable proportion of the spinning-tubes, which have apparently some differences in structure, have also a different function to perform, such as cross lines of the geometric web and "bead globules." This is mere surmise, but the fact of the small number of ultimate filaments in relation to spinning-tubes remains.

A description of the mechanism of the spinning apparatus would make this paper too long. It would form the basis of a future communication, or the materials are at the service of any microscopist who wishes to work out the subject.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Germinal Layers and Early Development of the Mole.†—Mr. W. Heape gives the results of investigations upon the origin and formation of the germinal layers in mammals, more especially in the mole (*Talpa Europæa*), as follows:—

1. The *epiblast* of the blastodermic vesicle owes its origin as well to the inner mass of segmentation-spheres as to the outer layer of segments. It appears to originate in two ways:—

a. In the early stages of development (in the mole), probably by the cells of the inner mass being directly transformed into part of the wall of the blastodermic vesicle.

b. In a later stage (mole and rabbit), by the transformation of the rounded cells of the inner mass into a plate of columnar cells, which joins the part of the outer layer immediately above it to form the epiblast plate of the embryonic area.

2. The *mesoblast* in the mole is formed in two portions:—

a. A large portion, which has its origin in the primitive streak.

b. A smaller portion, which is derived from the hypoblast situated in front of the primitive streak.

The author was unable to distinguish where the latter, or hypoblastic mesoblast, comes into contact with the mesoblast of the primitive streak, and what part these respective layers take in the future development of the embryo.

3. A *neurenteric canal* is present in the mole similar to that formed in other types of Vertebrata, first appearing as a pit at the anterior end of the primitive streak, while in later stages it perforates the floor of the hinder end of the medullary groove.

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial " we.")

† Proc. Roy. Soc., xxxiii. (1881) pp. 190–8.

He also found in a seven days' rabbit embryo a rudimentary neurenteric canal, in the form of a shallow pit, in the epiblast at the front end of the primitive streak.

4. The *notochord* is formed of an axial strip of cells, which underlies the epiblast of the medullary groove, and which either never become divided into mesoblast and hypoblast, or in which such a division, if it does take place (as appears not impossible), is very soon lost. This strip of cells is originally continuous laterally with both mesoblast and hypoblast, but as the lateral mesoblast becomes converted into definite vertebral plates, the connection is lost.

There can, it is believed, be no doubt of the connection of the lateral hypoblast and mesoblast with the notochordal cells in the mole; in the rabbit, Mr. Heape is inclined to believe that a similar connection is present, but his evidence on this point is not yet conclusive.

Development of Amphioxus.*—In this paper Dr. B. Hatschek deals in detail with the earlier stages only. In describing his method of study, he says that he has always endeavoured to study in the living object all that it would allow. For the preservation of specimens in the cleavage stage Kleinenberg's fluid was found useful; and coloration was effected by osmic acid: the former was not adapted for the gastrula-stage, when osmic acid was used. The earlier stages of segmentation require a treatment different to the later, on account of the large amount of yolk then present; an addition of $\frac{1}{2}$ per cent. osmic acid to the sea-water killed the embryo in the earlier stages, when no colouring matter was employed; in the later stages Beale's solution or picrocarmine were found useful.

Oviposition is seen to be markedly dependent on the weather and the time of day; the generative products are most certainly expelled by the mouth. Development breaks up into two well-marked stages, the one embryonic, when it is effected at the cost of the nutrient material contained in the egg, and is very rapid. At the close of this period the mouth is developed, and the first gill-cleft. The larva now begins to feed itself, its cells contain transparent protoplasm, and the developmental processes are very much slower.

While giving a general support to Kowalevsky's classical account of the earlier stages, the author finds that the ova are generally quite isolated. The five fat-bodies of the Russian author are regarded as yolk-granules; the spermatozoa would appear to always enter at the vegetative pole. The cleavage was found to be unequal, the differences between the two poles being well marked. There is a pause of about an hour between the formation of the first and of the second groove.

At the blastula-stage we find the investing cells taking on an epithelial character, till there is formed a general outer layer, enclosing a cavity. This simple epithelium forms the substratum for the later developmental processes; all the essential organs are formed by foldings or outgrowths from it. Bilateral symmetry is obvious at a very early period; the blastopore appears to close from before back-

* Arbeit. Zool. Inst. Univ. Wien (Claus) iv. (1881) pp. 1–89 (9 pls.).

wards. The lower layer, which goes to form the endoderm, does not correspond to more than one-third of the blastula; this undergoes invagination, the fluid of the cleavage cavity becomes absorbed, and bilateral symmetry soon becomes well marked.

In the "third period" the primitive segments, the nervous system, and the notochord begin to be apparent; the remnant of the blastopore persists as an opening between the enteric cavity and the nerve-tube, representing the typical neuro-enteric canal. Contemporaneously with the development of the nerve-tube, the mesoderm developes the primitive segments; two lateral longitudinal folds arise in the dorsal portion of the endoderm, and represent the rudiments of the mesoderm. The cavities of the primitive segments are diverticula from the archenteric cavity.

After describing these points in detail, the author makes some observations on the mechanics of the developmental process. All those described are referable to foldings, solutions of continuity, or outgrowths. What are the causes of the first? Some are due to contractions of the protoplasm, to active changes of form, while others are referable to growth; in the others we have to note as an important factor differences in growth-energy. Active changes are limited to short periods, and the formation of the dorsal groove is an example; with this the development of the mesodermal folds has a close mechanical connection. Growth is more energetic in the anterior regions. The prime cause of the development of the mesodermal folds would appear to be the greater superficial extension of the endoderm in the dorsal region; so, again, the formation of the first primitive segment commences by a flattening of the anteriorly placed endodermal cells; the cells pushed back are folded transversely, and so give rise to the first primitive segment.

In the stage in which there are seven primitive segments there appear in front of them two dorsal folds of the endoderm; these become more and more marked, and give rise to two blind sacs, which are at first bilaterally symmetrical, and are placed at the anterior end of the enteric canal. About this time the epithelial cells become for the most part much more flattened; and the dissolution of the yolk-granules is almost completed.

The fourth stage is the period of histological differentiation, muscles become apparent, the notochord undergoes histological differentiation, and fibrous cords appear in the medullary tube. At the same time the larva alters greatly in form, becomes elongated and compressed, and takes on generally a piscine character. The increase in the number of primitive segments goes on but slowly, but what are formed gradually fuse in the ventral median line. Each muscle-cell has at first only a single fibril, and there is no indication of segmentation; we may say, indeed, that a row of cells secretes a common fibril, which is continuous throughout the length of the body. The author cannot agree with Kowalevsky in thinking that there is any special chordal sheath, and he does not see here any difference from what obtains generally throughout the Vertebrata in the histological differentiation of the notochord; small vacuoles appear within its

cells, grow in size and diminish in number, till at last they are so extensive that nothing but thin partitions intervene between them.

The anterior endodermal sacs undergo development asymmetrically; they become shut off from the exterior, the one on the right increases in size, while the left undergoes no change, till at the commencement of larval life it opens on the left side of the body by a small orifice. This is the special organ of larval life, as described by Kowalevsky. Another organ, the club-shaped gland, is also developed from the exterior. Formed in the region of the first metamere, it becomes towards the end of embryonic life shut off from the exterior. It now lies chiefly on the right side, but extends transversely across the enteric canal, and opens at the outer margin of the mouth; part of it becomes glandular, and the rest forms an efferent duct. The external epithelium is still ciliated, but is now generally thinner.

In the fifth period, the last here described, those changes occur which enable the embryo to pass into the larva. A number of orifices are now formed, the mouth and the first gill-cleft, the orifice of the ciliated organ (or left endodermal sac), the club-shaped gland, and the anus. The body meanwhile increases in length, fresh segments being formed, a number of strong motile flagella may be seen to be developed from the cells, and all the tissues of the body are now formed of transparent protoplasm.

B. INVERTEBRATA.

Fossil Organisms in Meteorites.*—In his own abstract of his detailed memoir on this subject, C. Vogt says, "I have endeavoured to discover whether the bodies to which Dr. O. Hahn calls attention,† really have the structural characters of the organisms to which he has assigned them.

"By a detailed comparison of the living and fossil sponges with the supposed sponges of meteorites, I am able to show that there is no resemblance in microscopical structure between them. I prove, by the same method, that neither the corals nor the Crinoids which Hahn believes that he has discovered in the meteorites have anything in their microscopic structure in common with living or fossil corals or Crinoids. I further refute the theory, which may be described as at least singular, according to which the corals are only an evolutional development of the sponges, and Crinoids a product of the further evolution of the corals.

"I demonstrate the fact that, in order to obtain the completest possible knowledge of the structure of the chondrites" (the species of meteorites from which the specimens were prepared) "we must resort to check-experiments, based on dissociation of the constituent elements either by chemical reagents (as acids and caustic potash) or by the mechanical operation of grinding to the finest possible sections. The fragments which are obtained in this way should be studied by

* Comptes Rendus, xciii. (1881) pp. 1166–8.
† See this Journal, i. (1881) pp. 722–4.

polarized and not merely by ordinary light. The check-experiments show with the greatest conclusiveness that the chondrites are entirely composed of crystalline pieces, variously disposed, and that organic structure is quite absent from them.

"I then pass on to compare the structure found in the chondrites with those of artificial products which have been brought to the knowledge of the Academy by MM. Daubrée and Meunier. I prove, by camera drawings, that various crystalline forms which may be seen in meteorites were long since reproduced by M. Daubrée, and that the incrustations of enstatite made by M. Meunier exhibit under the Microscope the same radiating and jointed arrangement as the so-called organisms of Hahn. Finally, I demonstrate that the columnar formation which is only revealed by the use of the polariscope and by shaking, and which may be seen in certain chondrites, is also found in rocks belonging to the globe under the same conditions.

"The comparative method of study which I have adopted, aided by drawings made from nature, leads me to the following conclusions:—(1) The alleged organisms of meteorites (chondrites) have no existence; what have been described and figured as such are made up of crystalline bodies, entirely inorganic. (2) None of these alleged organisms have the microscopical structure which belongs to the real organisms with which they have been associated; in particular, the so-called sponges do not exhibit the structure of the living or fossil sponges, nor the corals the structure of zoophytes or Anthozoa, nor the Crinoids that of the known forms of Crinoids. (3) The structure which has been observed is either due to the presence of an opaque encrusting substance, or is the result of optical illusions caused by an incomplete method of microscopical examination. (4) The study of thin sections, obtained by grinding, carried only up to a certain point, is insufficient to elucidate the structure of the chrondrites. This method of investigation must be controlled by observations made on sections reduced to an extreme degree of thinness, as well as by the examination of chondrites dissociated by acids and caustic potash. (5) The check-experiments show conclusively that all the chondrites are composed of transparent crystalline masses, grouped in different ways, but most usually in the form of miniature columns or ramified tufts radiating from a centre. The interstices, fracture-cavities, and gaps between these masses are filled with an opaque incrusting material, a considerable part of which resists the action of acids, and both simulates septa and has definite shape and other peculiarities which are attributed to organic structures. (6) The tufts which make up the chrondrites are identical in their form and in the manner in which the crystalline pieces composing them are arranged, with the tufts of artificial enstatite, obtained by Meunier in his experiments; just as the globular masses of crystals formed during the same experiments, are analogous in their manner of grouping to chondrites of ramifying and jointed structure. (7) In certain finely striated chondrites, a rectilinear columnar arrangement may be seen, identical with the structure of certain terrestrial enstatites (*Schifferfels* of Baste, in the Harz). (8) The greater number of chondrites contain a quantity of groups of enstatite crystals, identical

in their mode of grouping, their form, and structure with those obtained by M. Daubrée by fusing peridote with wrought iron (*fer doux*). (9) Deducting the pulverulent and metallic substances, and the uncrystallized encrusting materials, ordinary meteorites consist only of crystalline elements united to form chondrites; this is proved by disintegrating them by rubbing or by the use of acids.

Red Pigment of Invertebrates (Tetronerythrine).* — At the coast it may readily be observed that a red coloration is very common among invertebrate animals, and even fishes. And according to C. Mereschkowsky, even the animals coloured yellow, brown, green, and black, have always a scarlet red pigment, which in their case is hidden by others. The red pigment, he finds, is always the same substance, viz. that known as *tetronerythrine;* he has verified its presence in one hundred and four species (invertebrates and fishes). The question arises, what is the physiological *rôle* of this widely expanded substance? The author finds evidence that it corresponds to hæmoglobin in higher animals: serving for cutaneous respiration by virtue of its great affinity for oxygen. Thus, as regards distribution in organs, wherever oxygen has to be largely consumed by the tissues, there tetronerythrine is abundant. This is illustrated by skin tissues in immediate contact with the oxygen of the water; by the organs of respiration (e. g. in sedentary Annelids the tetronerythrine is concentrated in the branchiæ, the rest of the body having only traces); by muscles, and such an organ as the muscular foot of Lamellibranchiates. Next, as to distribution in the animal kingdom: sedentary animals are often redder, and have more tetronerythrine than errant animals; the latter which, by constant change of place, are always in water holding plenty of oxygen, not having the same need of a special substance to increase the oxygen absorbed by the tissues. Then the fact that tetronerythrine occurs by preference in invertebrates, where hæmoglobin is wanting (and only exceptionally in higher animals), points to similarity of function in these substances. It is further pointed out that animals provided with yellow cells (parasitic algæ), which are proved to produce free oxygen in the tissues, are without tetronerythrine, or have very little of it.

Mollusca.

Maturation, Fecundation and Segmentation of Limax campestris.† —In this remarkable contribution to embryology, E. L. Mark deals in the first sixty pages with his own observations; the rest of the paper falls under the head of bibliography, and we have nearly three hundred pages devoted to a consideration first of the egg-envelopes and yolk of *Limax*, and secondly of a review of maturation, fecundation, and cell-division; asters, quiescent nuclei, and nuclei in division are successively taken in review; and for the last, tissues as well as plants are examined; the paper concludes with theoretical considerations and conclusions, in which attention is drawn to such important points as the promorphology of the ovum, asters, origin of nuclei, and

* Comptes Rendus, xciii. (1881) pp. 1029-32; Nature, xxv. (1882) p. 276.
† Bull. Mus. Comp. Zool., vi., No. 12 (1881) pp. 173-625 (5 pls.).

polar globules, among others. An alphabetical bibliographical list, and a list of the authors cited in the text aids the reader in his study of the work.

The eggs, usually found in clusters of about a dozen, vary in their mode of packing, and in their arrangement in the cracks of earth which shelter them; their more or less plump appearance depends on hygrometric conditions, and they are not always of the same form. When first deposited, the yolk is much denser than the surrounding albumen, but it is not provided with any proper vitelline membrane.

At first the changes occur very slowly, but soon they succeed one another more rapidly. First one and then the second polar globule appears, and, as a rule the latter is somewhat smaller. In dealing with the formation of the female pronucleus, the author points out that it constantly remains near the surface of the vitellus; its diameter may eventually attain one-fourth the diameter of the whole vitellus, or, in some cases, one-third. When treated with acetic acid, the female pronucleus is modified in shape by the formation of a number of deep wrinkles and folds; when with osmic acid (and subsequent staining in carmine), it has a delicate and even outline, and its form is spherical, pyriform, or oviform. Soon after extrusion, a number of small ovoid bodies of high refractive power are to be found near the vitellus, presenting a filamentous appearance in some cases; they are, doubtless, all spermatozoa; they may be present in great quantities, and even form "trains" through different parts of the albumen. In one case an undulating membrane was noted in a spermatozoon.

After dealing with the characters of the male pronucleus and its history, the author passes to cleavage; here he finds that the first cleavage nucleus does not have a morphological existence; this is explained by assuming that the acceleration at this stage of the ontogeny is so great that the division of this future structure is begun before it has an actual independent existence. He is further of opinion that a differentiation commences in the superficial portion of the yolk, which is the first step toward the formation of a cell-membrane, and that this differentiation is proportional to the advance of cleavage.

It is impossible to enter into the details of the elaborate account of previous naturalists' observations which form the great bulk of this communication, which was apparently in the press before the publication of Mr. Balfour's systematic treatise.

Kidney of Chiton.*—Mr. A. Sedgwick gives an account of the structure of the kidney of *Chiton*, which is a paired gland constructed on the type always found in molluscan renal organs. It consists of—

1. A duct opening to the exterior in the pallial groove behind the generative opening, and internally into the pericardium.
2. Glandular cæca opening into this duct.

The duct may be described as consisting of three parts:—(1) The part into which the glandular cæca of the kidney open. This

* Proc. Roy. Soc., xxxiii. (1882) pp. 121–7 (2 figs.).

part is open to the exterior behind. In front it bends round, and runs backwards to about the level of the 5th shell plate, where it changes its character, and is continuous with (2) a duct containing brown colouring matter in the columnar cells lining it, and receiving no glandular cæca. This part extends back to the level of the last gill, where it turns outwards, and becomes continuous with (3) a part running forward for a short distance close to the lateral nerve, and lined by large ciliated columnar cells. This opens in front at the level of the penultimate gill into the pericardium. The author expected to find the communication between the two parts of the renal duct behind, in the region of the bladder, and for some time was puzzled at not finding it. Mr. Balfour however suggested that the communication might possibly be found in front, reasoning from the analogy of the structure of the kidney in other Mollusca, and on examining the anterior part more carefully, the two parts of the gland were found to be communicating.

Morphology of Neomenia.*—Messrs. A. Kowalevsky and A. F. Marion believe they have made the somewhat remarkable discovery that all naturalists who have examined this form have mistaken the posterior for the anterior end. They are enabled to show that the "lateral glands" of Tullberg are salivary glands, and that the organ called the radula is really the penis. The description of the present writers is in accordance with that of *Proneomenia* as lately given by A. A. W. Hubrecht; † but we reserve details till the publication of their fuller paper.

In another paper ‡ Hubrecht affirms his belief that it is the authors and not previous investigators who have misunderstood the matter.

Molluscoida.

Organization and Development of the Ascidians.§—A proper body-cavity in the Ascidians has been found by E. van Beneden to exist only in the larvæ. The species chiefly examined were *Phallusia mentula*, *P. mamillata*, *Ciona intestinalis*, *Perophora listeri* and *Clavellina Rissoana*.

The larval mesoderm is found to consist of a right and a left lamina, derived from the primitive endoderm, and limited to the posterior part of the body. Each of these plates is divided into a posterior portion, formed of a single layer of cells, and giving rise to the muscle-cells of the tail, and an anterior one, which in *Perophora* and *Clavellina* is bilaminar and encloses a cleft opening into the alimentary canal and roofed in above by the chorda dorsalis.

At a later period the anterior mesodermic cells lose their epithelial character, acquiring that of the adult blood-corpuscle, and becoming distributed to the epiblast, the central nervous system, and the hypoblast of the alimentary tract. A similar change comes over the endodermic cells of the floor of the neuro-intestinal canal, and the scattered cells give rise to the blood-corpuscles, the connective tissue, the body-

* Zool. Anzeig., iv. (1882) pp. 61–4. † This Journal, *ante*, p. 31.
‡ Ibid., pp. 84–6. § Comptes Rendus, xcii. (1881) pp. 1238–41.

muscles, the pericardium, and the sexual organs. In the bud of *Perophora* all these parts arise from the blood-corpuscles contained between the epi- and hypoblast.

In the adult of *Perophora* the wall of the heart is unilaminar; and the protoplasm of the deeper parts of its constituent cells takes on the structure of muscular fibrils. There is no cardiac endothelium. The wall of the heart is only a continuation of the visceral fold of the pericardium. This comes about from the fact that the mass of mesodermic cells from which the pericardium is developed is bilaminar, and a cavity appears between the laminæ, forming the pericardiac cavity; the inner lamina encloses a chamber which fills with corpuscles, and it becomes the wall of the heart.

In the primitive mass of mesodermic cells destined to form the sexual organs an excentric cavity appears, becoming the *sexual vesicle*; this divides into an exterior, female, and an interior, male portion; both are hollow and open into a long common tube formed of flat cells, which lies between the intestine and the gastro-œsophageal part of the alimentary canal, ending blindly at each extremity. This tube by growth becomes folded on itself, and its external section becomes the oviduct, its inner one the vas deferens; the posterior inflated end of the latter becomes the testis, which, single at first, becomes multilobate. The ovary arises by the conversion into germinal epithelium of the flattened epithelium of the posterior end of the oviduct; the primitive ova thus formed become imbedded in the investing connective tissue and form a follicular mass. The ovum falls into the oviduct when mature. At first the vas deferens opens into the oviduct, but when the cæcal anterior end of the latter opens into the cloaca, the opening of the former reaches the cloaca also and becomes independent. The strong analogies which exist between the development of the pericardium and the sexual vesicle show that if the pericardiac chamber is homologous with that of Vertebrata, that of the sexual organs corresponds with the abdominal cavity.

The body-cavity (" enterocele ") of the larva completely disappears, for the epithelial cells which line it expand into a " blastocele," and then form a continuous mass, or mesenchyme. There is thus no radical distinction between the mesoderm and mesenchyme as held by the brothers Hertwig to be the case. In their structural characters and in the mode in which the nerves terminate in them, the muscles of the adult approach the smooth muscular tissue of Vertebrata, but those of the heart are peculiar in consisting of parallel fibrils placed in the deeper parts of epithelial cells.

It follows from the above facts that the mesenchyme has not always the same origin or the same anatomical importance in the animal kingdom. In the Cœlenterata and Vertebrata it is a *primitive* mesenchyme, as being produced by contact with an epithelium; in the Ascidians it is *secondary*, for it results from the dissociation of the cellular elements of an epithelium (the original mesoderm). The muscular fibres which originate from cells of the mesenchyme appear to be always fibre-cells, whether the mesenchyme is primitive or secondary.

"Challenger" Ascidians (Culeolus).*—Dr. W. A. Herdmann forms the genus *Culeolus* for a series of six new species of pedunculated simple Ascidians, belonging to the family Cynthiidæ, and having several anatomical peculiarities distinguishing them from all hitherto described genera. The nearest ally of *Culeolus* is *Boltenia*, and these two genera have been placed together as a sub-family, the Bolteninæ, characterized as Cynthiidæ which have the body pedunculated, the tentacles compound, and the branchial sac with more than four folds on each side.

Culeolus is distinguished from *Boltenia* by its remarkable branchial sac, and by the external character that its branchial aperture is triangular, and its atrial aperture bilabiate, while in *Boltenia* both apertures are four-lobed. The branchial sac is in all respects, except the possession of a certain number of longitudinal folds on each side, the simplest form known among simple Ascidians. It may be described as a simple network, formed by two series of vessels crossing at right angles and communicating at the points of intersection. In its vessels is found an extensively developed system of calcareous spicules of considerable but varying size, often much ramified, and having a very characteristic appearance from their gentle curves and blunt ends.

One of the species, *C. murrayi*, is described in detail, anatomical and histological, while the other five are not so fully treated, but the different systems in each are compared with those of the type, and the modifications are pointed out.

All the species are from upwards of 600 fathoms; five are from over 1000 fathoms, four from over 1500, and two from upwards of 2000 fathoms. They all belong to the abyssal fauna. It is noteworthy that these six species, the only deep water Bolteninæ, all belong to one genus, notwithstanding their wide distribution in space, one species being from the North Atlantic, two from the Southern Ocean, one from the South Pacific, one from the North Pacific, and one from the centre of the Pacific Ocean on the equator.

Embryonic Membranes of the Salpidæ.†—Dr. J. Barrois finds that some of the discrepancies between the accounts of Salensky and Todaro, which appeared almost simultaneously, are to be ascribed to the extreme diversity in the developmental history of the members of this group of the Tunicata; and he is able to speak to the correctness of their accounts of the different forms examined by them.

The first species now described is *Salpa maxima*, and we see that much that is true of it is true of other forms also. The appendages are either extra-fœtal or embryonic. When the ovum has reached its definite position its follicle has the form of a rounded vesicle, with three thick walls, and is attached to the base of a shallow depression in the wall of the branchial sac; segmentation is now somewhat advanced. The follicle becomes oval, and the depression becomes converted into a cul-de-sac, which projects considerably into the interior of the respiratory cavity; in this cul-de-sac the follicle is

* Proc. Roy. Soc. xxxiii. (1882) pp. 104–6 (1 fig.) (Abstract only).
† Journ. Anat. et Phys. (Robin) xvii. (1881) pp. 455–98 (2 pls.).

completely lodged. This process becomes more and more marked, and the egg begins to exhibit a segmentation cavity. Two grooves appear, and divide the cul-de-sac into three portions; as they deepen, the sac gets the form of an irregular mass, and the median portion gives rise to the peripheral layer (placental membrane, Todaro) of the placenta; in the next stage the lower wall of the follicle increases in size and gives rise to a mass of several rows of cells, which will go to form part of the placenta. The fold formed from the inferior divisions of the sac forms two layers of the circular fold, which is destined to cover the whole of the embryo (*caduca externa*, Todaro). During this process the superior division of the cul-de-sac has become much more completely attached to the upper portion of the follicle. The circular fold grows more and more over the embryo.

The embryonic appendages are thus developed: the outer layer of the embryo becomes applied to the inner face of the follicle, its lower portion, with which there is connected the mass formed by the internal layer, separates from this follicle, and so gives rise to the placental cavity; that portion of the outer layer which invests it is the *fœtal placenta*, the rest of the embryo forms the endoderm and apparently the rudimentary ectoderm. A little later the young *Salpa* becomes invested in a single layer which forms its skin, the endodermic mass becomes completely detached from the fœtal placenta, and forms a nucleus around which the principal organs are developed. The fœtal placenta unites with the placental membrane to form the complete placenta, a third layer in which is formed from the mass of several rows of cells, already mentioned. The fœtal placenta increases in size and then undergoes a retrograde development; thus the structure of this part is simplified. The remaining stages are simpler.

There are, then, three parts concerned in the formation of the embryo and its appendages; two, the follicle and an expansion of the wall of the branchial sac, are developed from the mother; the third is formed from the egg. The upper portion of the primitive cul-de-sac forms the outer wall of the primitive incubation-cavity, the fold at the base bounds the definite uterine cavity, while the median portion gives rise to the placental membrane. From the ovum the embryo proper and the fœtal membrane are developed. The author thinks that the so-called placental membrane has really no placental function, but rather serves to keep the incubation-sac in its place in the middle of the great uterine cavity. Reduced to its simplest terms, we may say that the mother furnishes two incubatory pouches, connected by a membrane which maintains the first within the second pouch, and the maternal placenta; while to the embryo there is to be ascribed a simple expansion, which, like the allantois of the Mammalia, is destined to form the central portion of the placenta.

Modifications of the Avicularia in Bryozoa.*—Mr. T. Hincks considers that there can be no reasonable doubt that the vibraculum is a derivative from the avicularium and not an independent modifica-

* Ann. and Mag. Nat. Hist., ix. (1882) pp. 20–5 (4 figs.).

tion of the oral valve of the zoœcium, and he shows that the leading stages exist in *Schizoporella ciliata*. Sometimes a moderately short avicularium of the ordinary type occurs; in other cases the mandible is more or less prolonged into a straight and slender spine. In specimens from the Queen Charlotte Islands the mandible has altogether lost its lid-like character and is now a very tall membrano-chitinous appendage, commonly exceeding in length the entire cell; from Ceylon or Bass's Straits still another form is known, in which the spinous process of the avicularium is furnished on each side with a delicate membranous expansion.

It is suggested that in the avicularian appendages is to be found a ready adaptability to change of circumstances, and Mr. Hincks considers that these observations bring out very forcibly the instability of the avicularian structure, so that he cannot agree with those who assign a high value to the appendicular organs for the purposes of classification.

Arthropoda.

α. Insecta.

Flight of Insects.*—R. von Lendenfeld, after some general considerations on locomotor organs, points out that insects with one pair of wings appear to be the most highly organized and possess the largest brain. Before the Jurassic period no two-winged insects seem to have existed; these later ones would appear to have been derived from the four-winged forms. The "dipterous" type seems to have been developed along two different lines; while in the Lepidoptera Rhopalocera the anterior wings are the larger, in the Orthoptera genuina the hinder are the larger; allied to the former are the Sphingidæ and the Hymenoptera with the anterior wings much the larger, and they culminate in the true Diptera in which the anterior wings are alone developed. On the other hand, the Orthopterous form leads through the Coleoptera, where the anterior wings form elytra, to the Strepsiptera, in which the anterior wings are aborted; lower than all these are the Neuroptera planipennia and the Libellulidæ in which both pairs of wings are equal in size. In discussing the question of the homology of the wings, the author states that his own observations incline him to the view of Fritz Müller that they are derived from lateral processes of the dorsal plates of the wings on which they are found, and that they are not modified tracheal gills.

The rest of the paper deals in detail with the characters presented by the Libellulidæ. A diaphragm of chitin separates the muscles for the wings from those for the legs; the exoskeleton is made up of a number of thin chitinous plates; there are various methods of articulation, some of which are exactly comparable to those that are found in the Vertebrata. Sixty-two separate skeletal parts are named and described. The wings are not only similar in structure but in action and function; the quantity of blood which makes its way into

* SB. Akad. Wiss. Wien, lxxxiii. (1881) pp. 289–376 (7 pls.).

them is very much less than it is, for example, in the Lepidoptera, and their wings are therefore exceedingly light.

The sixteen muscles and two ligaments are named and described, and an account is given of the method adopted for securing instantaneous photographs of the insects' wings. Two phases are to be distinguished in the movement of the wing, the movement from behind forwards, and from in front backwards; in both, however, there is an upwardly acting force; with this, there are associated other movements, resulting in the course of the wing being a more or less complicated curve, the directions of which depend of course on the extent to which these other forces act.

Nucleus of the Salivary Cells of the Larvæ of Chironomus.*—E. G. Balbiani reminds his readers that in 1876 he noted how the epithelial cells of the ovary of the Orthopterous insect, *Stenobothrus pratorum*, contained in their nuclei not ordinary nucleoli, but a large number of small subequal granulations, which he compared to a mass of bacteria. He showed that these united to form the filaments of the nuclear figures which characterize the different stages of the division of the nucleus (Karyokinesis), and that it followed that the nuclear filaments were not, at first at any rate, homogeneous, but formed of granules set along a single line. Confirmatory observations have lately (1881) been made by W. Pfitzner on the Salamander; but instead of using his complicated method of demonstration, the author has found that it is sufficient to treat fresh cells with acetic or chromic acid: when the action is prolonged the globules may be seen to fuse more or less completely with one another, and to give rise to filaments which are sometimes varicose, and sometimes completely homogeneous; it is under this condition that the nuclear filaments have generally been described and figured.

The salivary glands of *Chironomus* are two flattened organs, formed of a small number of large clear cells, with large nuclei, transparent, like the cells themselves; in the nuclei there are two large nucleoli formed by a granular refractive substance, and containing a more or less large number of vacuoles. In addition to these, there is a pale body of the form of a cylindrical cord, which is coiled upon itself in an intestiniform fashion. In larvæ of some age it is often broken up into filaments of varying length which may either remain free, or become attached to the envelope of the nucleus. Some little way from each extremity the cord is suddenly swollen out, and this may be described as a ring; when the cells are allowed to die in the blood of the animal, the ring, which was previously difficult to detect on account of its paleness, becomes finely granular, and so more evident. In living cells it is perfectly homogeneous, being neither granulated nor vacuolated. Entering into a detailed account of the cord, the author describes its transverse striæ and the disks of which it seems to be composed.

The influence of reagents reveals a difference in chemical composition; distilled water causes the cord to swell, till it becomes

* Zool. Anzeig., iv. (1881) pp. 637–41; 662–66.

almost invisible; the nucleoli resist the action for a longer time. Acetic or chromic acids (1 per cent.) or concentrated picric acid bring out the details of the nucleus, the disks of the cord, the rings at the extremities, and the nucleoli. After giving an account of the action of various colouring matters, the author says that he thinks no one will doubt that the cord is homologous with the intranuclear network of other nuclei; and that it is not, as most have supposed, really formed of homogeneous filaments, continuous with the nuclear membrane, and largely ramifying and anastomosing. The network has nearly always been described after the action of reagents on it; it is now seen how much these affect its original characters.

The nuclei of the cells of the larvæ of *Chironomus* may be looked upon as very complex elements, offering a true organization, if by that term we understand an assemblage of parts having fixed and constant relations to one another, and fulfilling special functions. As to the functions of this apparatus and its mode of activity, hypotheses are at present useless; not only animal, but also vegetable cells must be more closely studied, and the two carefully compared. In conclusion, notice is taken of the observations of Baranetzky on the pollen-cells of *Tradescantia*, where obscure transverse striæ were seen in the nuclear filaments, and a clear intranuclear substance, comparable to that found in *Chironomus*, was detected.

γ. Arachnida.

Structure of the Dermaleichidæ.*—After describing in detail the mouth-parts of these Arachnida, Dr. G. Haller directs attention to certain characters in the digestive tract which point to their close affinity with the Tyroglyphida and Dermacara; the tract being simple, and the saccular stomach divided into two parts, lying one behind the other, and not differing in function.

So again, in the structure of the male organs we find a not inconsiderable resemblance to the Tyroglyphida; the testes and their ducts are paired, the seminal vesicle and reproductive organ are unpaired, while the male is provided with organs of attachment, and with accessory organs developed on the extremities. Further investigation into details proves, however, that we have here to do with forms of a more lowly organization. Two, and in some cases three, different forms of females were observed. The first of them was impregnated by the male, but had no indications of any generative organs; the next had a matured ovum in its oviduct. The former of these is really an eight-legged larval form, and it is only in the next stage that the matured female is really present. The author justly directs attention to this remarkable peculiarity.

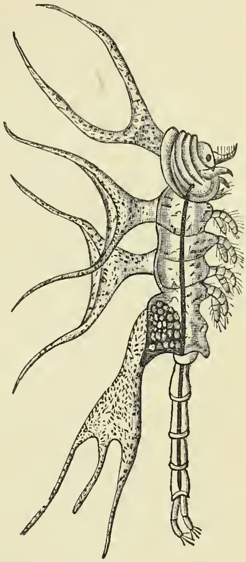
δ. Crustacea.

New and rare French Crustacea.†—M. Hesse here describes *Bimonaste bicolor* and *Scotophilus tricolor*, two parasitic Copepods

* Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 367–88 (2 pls.).
† Ann. Sci. Nat. (Zool.) xi. (1881) art. No. 8, 19 pp. (2 pls.).

which he found living in Ascidians. He also gives a further account of *Notopterophorus papilio* and *N. bombyx* (see Fig. 28), remarkable forms in which the body is provided with large delicate membraneous lamellæ, not unlike wings of Lepidoptera. The head has a kind of covering which is surmounted by two narrow expansions, longer in the female than in the male, and not found in the young. The wing-like expansions are attached to the dorsal portion of the thorax; they are evidently too delicate for any marked action, and it is probable that they are able to insinuate themselves between the tisues of their host; they can move with some rapidity, after the fashion of a butterfly's wings. When young, these curious creatures resemble a *Monoculus* in form. A systematic definition of the two species is appended, and reference for further details is made to the author's earlier papers (1864 and 1865.)

FIG. 28.



New British Cladocera from Grasmere Lake.*—Professor Ray Lankester points out that previous to his identification of *Leptodora hyalina* Lillj., and *Hyalodaphnia Kahlbergensis* Schödl, as British Cladocera in specimens from the Olton reservoir, few of the remarkable forms of Cladocera which occur in the larger lakes of the Continent, had been recognized as occurring in this country; but the list has now been extended by the observations of Mr. C. Beck, who, last summer, examined the Entomostracous fauna of Grasmere Lake, Westmoreland, and found the following species, three of which are new to British waters.

1. *Leptodora hyalina* Lilljeb. ♂. Taken Sept. 16th.
2. *Hyalodaphnia Kahlbergensis* Schödl. Abundant Sept. 9th to 16th.
3. *Holopedium gibberum* Zaddach. Thirty specimens, each encased in a gelatinous globe, Sept. 7th to 16th.
4. *Latona setifera* ♂ and ♀ Straus (Weissman). Sept. 3rd to 14th.
5. *Bythotrephes* sp. Sept. 14th. This appears to be a new species, distinct from the *Bythotrephes longimanus* of Leydig.

At the same time, Mr. Beck observed the following, already known to Baird as British species, but some being of rare occurrence: *Sida crystallina* O. F. Müller (Straus genus); *Daphnia vetula* Müller, *D. reticulata* Jurine; *Eurycercus lamellatus* O. F. Müller (Baird genus); *Alona quadrangularis* Müller (Baird genus); and *Peracantha truncata* Müller (Baird genus).

It appears probable that in lakes where species of the Salmonid

* Ann. and Mag. Nat. Hist., ix. (1882) p. 53.

Ceregonus are found, there also will be found the large deep-water Cladocera, such as *Holopedium* and *Bythotrephes*, which serve these fish as food.

The Entoniscida.*—Prof. R. Kossmann finds that only five previous papers by three investigators (F. Müller, Fraisse, and Giard) form the bibliography of this group. European forms are said to be hermaphrodite, while the Brazilian appear to be diœcious, but the author has found the males of the former, though their relatively smaller size is obviously a difficulty which may have caused the earlier incorrect statement. Two genera—*Entoniscus* and *Entione*—are recognized, and the differences between their males pointed out. In their case, as in that of the females, the peculiarities of the group, and their common characters with the Bopyridæ are insisted on; the differences between the females of the two genera of Entoniscida are duly noted, and the views of earlier naturalists critically examined. The author does not think it probable that there is any change of host, as Fraisse has supposed.

It is pointed out that two larval forms obtain with *E. cavolinii*; some of the differences which previous investigators have detected and looked upon as specific, he believes to be due to differences in age, and the tegumentary glands discovered by Fraisse have not been made out by Kossmann.

The Bopyridæ.†—In this third contribution to a knowledge of these forms, Prof. R. Kossmann deals with *Ione thoracica* and *Cepon portuni* n. sp. (found in *Portunus arcuatus*), of which he gives a careful account, with especial reference to the gills, and the differences between the male and female. So rare are these forms, that 10,000 Brachyura were in vain opened by Salvatore Lo Bianco, of the Naples Zoological Station, before it could be said that a Bopyrid was to be found in any European Crustacean. The parasitism of this creature is neither common nor rare, but only gives rise to local epidemics.

Vermes.

Anatomy and Histology of Scoloplos armiger.‡—W. Mau has selected this common form for a study of the Polychætous Annelids. The methods of examination have comprised the investigation of living forms, and of specimens hardened by being killed in picric or chromic acids, in which they were left for a fortnight; after washing, they were placed first in dilute and then in absolute alcohol; other specimens were killed in dilute, then placed for some time in stronger, and, finally, in absolute alcohol. The examples best adapted for sections were found to be those that had been treated with chromic acid. The most suitable colouring matters were saffranin, alum-cochineal, and picro-carmine. Sections were cut by the microtome or the razor after imbedding in paraffin.

* MT. Zool. Stat. Neapel, iii. (1881) pp. 149–69 (2 pls.).
† Ibid., pp. 170–83 (2 pls.).
‡ Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 389–432 (2 pls.).

After describing their habits and general form, the author gives a detailed account of their various organs. The cuticle is, as compared with that of the Oligochæta, excessively delicate (not more than 0·002 mm. thick); it is not provided with any tactile setæ or other processes, and when fresh, is with difficulty separated from the hypodermis; it is traversed by pore-canals, and there are, in addition to these, rounded lacunæ which are arranged in parallel rows. The hypodermis is best examined after treatment with chromic acid and alum-cochineal or saffranin; the latter colouring agent brings out the nuclei and the rod-shaped or spindle-shaped bodies; these are found in the intercellular substance, and there are in addition a number of pigment-granules. The muscular system is extraordinarily well developed, and consists of circular, longitudinal, and dorso-ventral muscles, as well as of obliquely-set muscles in the anterior region. As was to be expected, the cœlom or body-cavity is broken up by dissepiments into a number of chambers, which are most distinct in the posterior portion of the body. Into the formation of these dissepiments the dorso-ventral muscles enter; and the cavity only communicates with the outer world by means of the orifices of the segmental organs, the large pores which are found in the terricolous Oligochæta being here completely absent.

The most important point noticed in the enteric tract would appear to be the cæca, which are developed in its more posterior portion, and which have their walls specially modified; no definite opinion can be given as to their function, but they would appear to be secreting organs; they have some resemblance to the swim-bladder-like organs lately described by Eisig in the Syllidea,* but in this form they never contain gas, and their walls are not contractile. Passing to the nervous system, we find the author including the sub-œsophageal ganglia in the brain; the ventral cord is surrounded by muscles, and is not, as in most Ariciidæ (McIntosh), outside them. Transverse sections show the existence of a more or less rounded space, which leads to a belief in the presence of a canal extending through the ventral medulla.

The circulatory system has closed vessels with proper walls, and there would seem to be no lacunæ; the stomach is richly provided with blood-vessels, and there is a pair of transverse vessels in each segment, which are, for the greater part of the body, eminently contractile. The blood is more or less red.

At the time of sexual maturity, the hinder part of the body of the male is whitish, and that of the female brownish-yellow in colour; the ova or sperm fill up the space between the intestine and the sides of the segments, but the generative products of one segment are prevented by the completely developed septa from making their way into another segment. The ova arise in a cellular tissue which lies near those vessels which intervene between the walls of the intestine and those of the body; the ova do not break away till they are completely matured, and they then do not, as in some other Annelids, float freely

* See this Journal, *ante*, p. 44.

in the cœlom, but are confined to the segments in which they are developed. The spermatozoa are developed in great quantities, and are, when ripe, excessively active; they resemble in form those of *Magelona*.

As efferent ducts for the products, we have the so-called segmental organs; they differ somewhat from those of other Chætopods, being tubular structures, in which it is not possible to distinguish different regions; the whole is very short, and only just extends into the cœlom; the external and internal orifices are somewhat widened out, but are not specially differentiated. They are not developed in the anterior portion of the body, where their place appears to be taken by a coil of cells with distinct nuclei; these are regarded as glandular organs, but no efferent ducts can be detected, and their development must be studied before their homologies can be exactly defined. The body easily breaks, and regeneration was found by experiment to be somewhat complete, 22 segments appearing where 42 had been before, 20 where there had been 33, 26 for 40, 27 for 63, and 24 for 68.

Parasitic Eunicid.*—Dr. J. W. Spengel, in describing *Oligognathus Bonelliæ*, remarks that parasitic Polychæta would seem to be very rare, the young Alciopids which are parasitic in Ctenophora affording the only other real exception to the rule that the Polychæta lead a free life. On examining some *Bonelliæ* at Naples, the author found in their cœlom an orange-coloured cord which attracted his attention by its lively movements. Not more than 10 cm. long, with a thickness of 1 mm. in its middle, it had more than 200 segments, together with a region of incomplete segmentation. The maxillary apparatus was rudimentary, and there were only three small teeth on the upper jaw. In the observations which follow his systematic account, the author enters into some comparison of the characters presented by this new form with those which are to be seen in some of its allies.

In dealing with its nervous system, the author points out that, while the œsophageal commissure contains but few ganglion-cells, there is a well-marked sub-œsophageal ganglion in the second segment; in the next six or seven, there are, as in it, two ganglia; further back, the swellings are inconsiderable; the elements of the ventral cord are arranged in typical fashion, save that the fibres form not two but three connecting cords. When compared with its allies, it is shown to be remarkable by the possession of a secondary ganglion in each segment, by the great breadth of its anterior ganglia, and by the close connection between the ganglia and the epidermis. In it the ganglia are all subequal, but in *Halla* the anterior ganglia contain a few giant-cells, each of which is provided with a special thick investment, formed of concentric fibrous layers with numerous spindle-shaped nuclei. The tubular sheaths thus formed are comparable to the "fibres tubulaires gigantesques" long since described by Claparède. After discussing the arrangements found in other forms, the author concludes that it must still remain uncertain

* MT. Zool. Stat. Neapel, iii. (1881) pp. 15–52 (3 pls.).

whether the tubes filled with pale soft contents which traverse the central medulla of so many Annelids, are, or are not, all homologous structures; there can be no doubt that the tubular fibres of *Halla* and *Arabella* are the same as the neural canals or giant fibres of the Oligochæta; but much still remains to be made out as to their connections with the cells and their function. This, however, is certain that the Annelida, no less than the Arthropoda and the Vertebrata, present marked variations in the size of their ganglion cells. Passing to the peripheral nerves, the author demonstrates the circular character of this system, which has already been detected in *Sipunculus* and *Echiurus.* A sympathetic system was found in longitudinal sections of the body, when pale fibres were seen to be running parallel to the ventral medulla, and apparently connected with it by secondary ganglia.

The greater part of the enteric canal is very simple, the only complications being in the anterior region. A series of regular folds are found behind the mouth, and project considerably into the lumen of the tube; their substance is mainly composed of muscle, and, as compared with other Lumbriconereids, they are rudimentarily developed in *Oligognathus.* After describing in detail the structure of the jaws, the author refers to a canal which opens on the ventral surface of the anterior portion of the enteron, and which he thinks, though material has prevented from coming to a definite conclusion, may be homologous with the secondary gut of the Capitellidæ.

The segmental organs present nothing specially worthy of note here, and the reproductive organs were not matured in any specimen examined.

Development of Anguillula stercoralis.*—Professor E. Perroncito gives an account of his observations on the development of this endoparasitic Nematode outside the human body. After a medical history of a patient afflicted with this worm, and who, till he went to work in the St. Gothard Tunnel, was remarkably healthy, he states that he was able to convince himself that *A. stercoralis* may be developed in the intestine of man, without the necessity of any free-living larval stage. When the embryo leaves the egg it is 0·2 mm. long, and 0·01 mm. broad. The larvæ leave the body at different stages of development; and when cultivated at a temperature of from 22–25° C., do not all complete their development, or become sexually mature. In what may be known as the second stage, or that which is reached after sixteen or seventeen hours, they are longer and more delicate, are enclosed in a delicate capsule, and the stomach has lost its chitinous armature; they now have on the whole a very close resemblance to the larvæ of *A. intestinalis.* Those larvæ which attain the adult condition, retain the capsule till they attain maturity; they may become as much as $\frac{1}{2}$ a mm. long. The sexes are separate, and the female is about a third longer and broader than the male, and contains about thirty eggs.

After discussing the zoological relations of this helminth,

* Journ. Anat. et Physiol. (Robin) xvii. (1881) pp. 499–519 (1 pl.).

Professor Perroncito elevates it into a new genus, to be called *Pseudo-rhabditis*, and he gives a technical definition. The larvæ are always killed at 48·5° C.; doliarine treated with hydrochloric acid occasionally, but not always, was a fatal poison, 1 per cent. solution of phenic acid was found to be constantly poisonous, as were other drugs, including an ethereal extract of male fern, especially when an alcoholic tincture of the same was added. The patient already mentioned was supplied by the author with an alcoholic liquor called *fermet*, and this was found to be mortal to the parasite.

Cercaria with Caudal Setæ.*—Mr. J. W. Fewkes describes a Cercaria, or larval Trematode, which differs considerably from anything he has been able to find in any published figures. The interesting feature is the Annelid character of the tail, a characteristic which he considers may indicate some new relationship between the Trematoda and the Annelida.

The Cercaria is marine, and always found at or near the surface of the water. Its length, when body and tail are extended, is about $\frac{1}{16}$ inch. The body walls are very transparent. Its motion through the water, as far as was observed, consists entirely of a "jerky" motion, brought about by the powerful strokes of its very muscular tail, a motion resembling very closely that of the nauplius of *Balanus*. With moderate magnifying powers, the motions of the tail are so rapid that they cannot be followed by the eye.

The head is very variable, its shape being sometimes contracted into a spherical ball, and at other times extended into an oval. At the extremity is the mouth. The stomach occupies a large part of the anterior central part of the body, and from it there is continued backward, a pair of blindly-ending vessels as in other Cercariæ. The most prominent structure of the body is a large medially placed sucker.

The tail is the most peculiar feature. Its general shape is hardly characteristic, and it owes its interest to the bundles of setæ arranged on opposite sides at intervals along the whole length. These setæ, of which there are many in each bundle, are straight, inflexible, and moved by muscles in the walls of the tail. Their resemblance to the setæ found in the segments of Annelids is very great.

New Type of Turbellaria.†—W. A. Silliman describes a singular worm which he found parasitic on a large green Nematoid, which was apparently parasitic on *Echinus sphæra*.

The body of the animal is sublanceolate, 2·25 mm. long, with an average breadth of 1·5 mm., and of a light brown colour. The suckers and hooks so characteristic of ectoparasitic Trematoda are wanting.

The epiderm is formed of tolerably regular hexagonal ciliated

* Amer. Journ. Sci., xxiii. (1882) pp. 134–5 (1 fig.).
† Comptes Rendus, xciii. (1881) pp. 1807–9.

cells, whose nuclei are very plainly visible. These cells are covered with a thin chitinous cuticle, perforated for the passage of vibratile cilia, by which the animal can move over the body of its host. The cilia of the ventral face are much longer and stronger than those of the dorsal. Beneath the epidermis is a basal membrane containing the brown pigment to which the colour of the animal is due.

No water-vascular system was observed, but its non-existence cannot be positively asserted.

The genital organs are the most remarkable characteristics of the animal. The male organs include numerous testicles and a penis enclosed in a sheath; the female organs a double ovary and *pseudo*-vitellogen, a uterus, and vagina. The testicles are placed in the anterior third of the body, and are in the form of small sacs, each with a very fine duct, which unite behind the intestine and debouch in the penis. The latter is a long canal of uniform diameter, which in a state of repose has numerous flexions. Its walls are muscular, and covered with a thin chitinous layer. It terminates in a sort of cirrus, ·018 mm. in diameter.

The uterus, like the sheath of the penis, is median, and situated below the latter; it terminates towards the middle of the body in a cul-de-sac, and more often than not contains an egg enclosed in an ovoid shell, which has an extremely long and fine peduncle. The shell and its peduncle would be secreted by the cells which line the wall of the uterus.

The pseudo-vitellogen occupies the second third of the body, and has the form of numerous ramified tubes, those on each side uniting towards the median line and debouching in the uterus. Immediately behind these openings are the ovarian cells; these are more or less in the form of a hand, of which the wrist communicates with the uterus, whilst the fingers are directed backwards and spread out. The eggs develope in the extremities of these fingers, and become larger in proportion as they advance towards the uterus. Their nuclei and nucleoli are very visible.

The vagina, which is never found in the Turbellaria, but is well marked in the Trematoda, opens on the dorsal surface in the posterior quarter of the body, and thence runs forwards towards the uterus. At the plane of the opening of the ovaries it dilates into a receptaculum seminis with muscular walls, which communicates with the uterus by a narrow and short canal.

This aberrant creature thus presents affinities (by the ciliated epiderm, digestive apparatus, male organs, and two ovaries) with the Turbellaria on the one hand, and (by the vagina and disposition of the pseudo-vitellogen) with the Trematoda on the other. Seeing that the young Trematoda are ciliated, but later on lose their cilia, the Trematoda may be considered as modified if not degraded Turbellarians. The animal in question being, therefore, a transition form, should represent a new suborder of Turbellaria.

The author proposes to designate it *Syndesmis*, in order to express its morphological *rôle*, and promises further details on the subject.

Systematic Position of Balanoglossus.*—Professor A. Giard has some observations on the paper of Metschnikoff † on this form, in which he points out that the presence in its larva, *Tornaria*, of a very special heart (which he has never observed in the larvæ of any Echinoderm), the relatively late appearance of the ciliated circlets, and the existence of a muscular band uniting the aquiferous system to the median point of the eye-spots, all present difficulties which prevent us from at once accepting the view of the close relationship of the Enteropneusti and the Echinodermata.

Attention is directed to one point of similarity; four years ago the author showed that, in the Echinoidea, after the reproductive period has passed, the genital glands form culs-de-sac filled with very large elements which have no resemblance to generative cells, and have within them a large vacuole, which owes its appearance to the atrophy of the nucleus; in addition, there are in the cell small brownish concretions, similar to those found in the renal organs of numerous Invertebrates; deutoplasmic elements which are, later on, absorbed by the developing genital cells, and a large number of crystals of phosphate of calcium are also present. From these observations the author concluded that, for a certain part of the year, the genital glands of Echinoids took on an excretory and a deutoplasmigenous function. A renewed study of Kowalevsky's memoir on *Balanoglossus*, showed the author that a very similar state of things was to be observed in that animal, but he here insists that it would be rash to give too much value to a morphological similarity which may be simply due to a similarity of function. A fair objection would be raised by any one who should point out that nothing of the kind is to be observed in the Starfishes. At the same time, the absence of segmental organs in *Balanoglossus* would seem to be very significant. If we distinguish the excretory apparatus of the Invertebrata as (α) protonephridia, e. g. the organs of Turbellaria, Cestodes, Trematodes, Rotifers, &c., and (β) the deutonephridia, or segmental organs properly so called, we find that we cannot place with the former either the water system of Echinoderms, or that of *Balanoglossus;* nor are they homologous with the modified deutonephridia.

The relationship of *Balanoglossus* to the Tunicata is absolutely denied, the resemblances between them being regarded as purely analogous; provisionally, therefore, Giard accepts the general doctrine of Metschnikoff, without pretending to exactly define the genealogical position of this curious and interesting form.

Nervous System of Platyhelminthes.‡—Of the fourth and fifth parts of Dr. A. Lang's contributions, the most important point is the discussion of the character of the nervous system as treated comparatively. Comparing them with the Ctenophora, the only group of the Cœlenterata which have a corresponding histological and anatomical differentiation of the germinal layers, the author points out that in

* Bull. Sci. Dép. Nord, iv. (1881) pp. 372–8.
† See this Journal, i. (1881) p. 462.
‡ MT. Zool. Stat. Neapel, iii. (1881) pp. 53–96 (2 pls.).

both the mesenchyma gives rise to muscular, nervous, and connective tissue. The nervous system of the Ctenophora consists of a nervous plexus scattered through the mesenchyma, of an ectodermal plexus with eight fibrous tracts, and of an ectodermal sensory body. In that of the Polyclades we distinguish a nervous plexus closely connected with the mesenchymatous musculature, which in all probability arose in connection with the musculature from the cells of that layer; a system of nerve-trunks, placed in the mesenchyma, connected by commissures and anastomoses, and radiating from a single point; of these eight are specially noticeable. The third portion consists of sensory organs (eyes), with sensory nerves, the prime origin of which appears to have been from the ectoderm. The three parts are here in connection with one another, and this, in addition to such differences as are due to adaptation, appear to be the only important points of distinction between the two groups.

Starting from the Polyclades, we may note that differentiation has proceeded in two directions—the one associated with the degeneration of the parasitic, the other with the elevation of the free-living forms. The brain is the point at which all the nerve-trunks meet; it is, therefore, largest in those forms in which the nerve-trunks are the best developed; and its size, in the Polyclades, though they are the most primitive of the Platyhelminthes, should not be any cause for astonishment. Among the Trematoda, *Tristomum* most nearly approaches them in habit and organization; the brain, however, is more simple. This simplicity is still more marked in *Pleurocotyle* and *Distomum nigroflavum*, where the brain is merely a transverse commissure. In *Amphilina* and those Cestoda in which the scolex is but feebly provided with muscles, the brain is so feebly developed as to be barely distinguishable; where, however, as in the Tetrarhynchi, the musculature is more abundant, the transverse commissures are correspondingly better developed.

In the Triclades the brain is feeble in the fresh-water forms; in the terrestrial ones it is impossible to speak of it as a definite central organ. In the marine forms, e. g. *Gunda*, it is highly developed, and consists of a large posterior, motor, transverse commissure, and a large anterior sensory commissure, the two being connected together by a sensori-motor commissure. After dealing with its position, the author passes to the *Peripheral portion*. The concentric arrangement of this in the Polyclades has been already referred to. As before, *Tristomum* presents the closest resemblance to that group, but certain changes have been effected, in consequence of the development of the ventral sucker, and there has been a reduction of the nerves at the anterior end of the body. In *Pleurocotyle* and *Distomum* little but the two longitudinal nerves have been preserved, and the commissural system would seem to have completely disappeared. In *Amphilina* the longitudinal trunks pass into one another; in the Tæniadæ the branches for the suckers are still retained; and the Tetrarhynchi have special paired nerves, which pass to the proboscis; no commissural fibres have as yet been detected in the Cestoda.

Along the other line of development the central nervous system

takes on an arrangement which strikingly calls to mind those found in the higher segmented forms; in consequence of the reduction of the lateral portions of the body and the simplification of the digestive and generative systems, the anterior and lateral nerve-trunks, as compared with the longitudinal trunks, have become quite inconspicuous; and in many cases the same fate is reserved for the brain.

The fresh-water Triclades come nearest to the Polyclades, but the longitudinal trunks unite posteriorly. The land forms, as represented by *Rhynchodesmus*, present us with an arrangement in which the brain is nothing more than a somewhat well-developed portion of the longitudinal trunks with transverse commissures somewhat thicker than in the other parts of the body. The regular arrangement of the peripheral portion is best seen in the marine Triclades, *Gunda* having longitudinal trunks which, at perfectly regular distances, are connected by simple unbranched commissures, and, so far as segments can be made out at all, there is a transverse commissure for each segment. The homology of this system is fully discussed.

The mesenchymatous nervous system consists, in the Polyclades, of a fine network of nervous substance which is closely applied to the ventral and dorsal muscular layers; the meshes are generally polygonal, and the system is best developed in the region of the sucker. In the terrestrial Triclades the meshes are generally quadrangular; in the Trematoda the system is best developed in connection with the large ventral sucker, and ganglion-cells of considerable size may here and there be detected in it. Among the Cestoda *Pleurocotyle* has the plexus largely developed near the proboscis.

No sensory organs, other than eyes, have been detected in the Platyhelminthes; a large number of these are always to be found in the Polyclades, in the Trematoda they are less numerous, and in the Cestoda they are either absent or are confined to the free-living stages. In most of the fresh-water and terrestrial Triclades two are alone found. In all cases there is presented a marked similarity of structure; optic cells, formed from the ends of the optic nerve, pigment-cups, and a crystalline body can always be made out.

No complete series of observations have been made by the author on either the Rhabdocœla or the Nemertinea.

The nervous system of the Triclades, the more general characters of which have already been pointed out, is dealt with in detail; in treating of the fresh-water forms the author has especially studied *Planaria torva*, and he finds himself in essential agreement with Graff, Kennel, and the Hertwigs.

In dealing with the land forms he has the advantage of Moseley's investigations into the land Planarians of Ceylon; a study which, he says, he has daily learnt to value more and more, though that author has called the nervous the primitive vascular system. This he regards as an error of interpretation which has been corrected by others, though the details have not been essentially altered.

Gunda has been the chief example of the marine forms, and the author has been able to distinguish in it a motor portion which is formed by two ventral enlargements, from which there arise the anterior

and posterior longitudinal nerves, and which are connected by motor transverse commissures. The sensory swellings are more dorsal and anterior in position; they give off the sensory nerves, and are likewise connected by commissures. Between these two sets there is a sensori-motor commissure. Histological structure no less than anatomical arrangement reveals the higher grade of development seen in the marine as compared with the other forms; the sensory are distinguished from the motor nerves by being invested in a continuous layer of ganglionic cells.

Structure of Gunda segmentata, and the Relationships of the Platyhelminthes with the Cœlenterata and Hirudinea.*— Dr. Arnold Lang commences by revising the classification of the lower Platyhelminthes: he would drop the term Turbellaria, and adopt in its place three orders, each of them the equivalent of the Trematoda, Cestoda, or Nemertinea; the dendrocœlous Turbellaria are either monogonoporous, or digonoporous, and for them he proposes the terms of Polyclades and Triclades, while the third order would be called the Rhabdocœla.

Gunda segmentata is a delicate marine Planarian about 6 mm. long, and very active; after giving a technical description of the species, the author passes to its epithelial layer, some of the cells of which are filled with the small characteristic rods, while others, on the ventral side, form a zone, which is broadest at the anterior end of the body; these attaching cells project considerably beyond the rest, and their free surface is roughened. The enteric system receives the name of the cœlenteric apparatus, inasmuch as the author is convinced that it is the homologue of the cœlenteric apparatus of the Cœlenterata, and of the enteron and cœlom of the Enterocœla. In all essential points it agrees with that of the other Triclades; the mouth leads into the so-called proboscis cavity, from the walls of which are developed muscular folds which project into the cavity, and form the proboscis, in the fashion of a diaphragm. The cavity communicates by an orifice with another cavity, which is not, as is the former, lined by ectoderm, but by endoderm; from this there are given off the branches of the intestine, the anterior of which lies in the middle line, and ends blindly at the anterior end of the body. The two lateral primary branches lie close to the sides of the proboscis-sheath, and end blindly at the hinder end of the body; from these three primary branches are given off secondary diverticula, the cœlomic diverticula of the enteron; these agree in all essential points with the paired cavities of the enterocœle of higher forms; they are generally unbranched, or are forked at their peripheral ends. There is no special musculature for the walls of the intestine; in the enteric cells we may sometimes see large vacuoles during life; these are called the excretory vacuoles. If we compare the above account with the arrangements which obtain in the *Ctenophora*, we find there that the so-called stomach is lined with ectoderm, and is provided with glandular ridges, that the succeeding cavity is lined by endoderm,

* MT. Zool. Stat. Neapel, iii. (1881) pp. 187–252 (3 pls.).

and that from the funnel there arise the gastro-vascular canals, in the form of paired ones which pass off laterally and branch, and an unpaired one which passes to the aboral pole, and there opens; on the other hand, the unpaired branch in *Gunda* only opens to the exterior in an early stage.

The Polyclades, like the Ctenophora, are hermaphrodite; and in both groups the generative products arise in close relation to the branches of the enteron; Chun has described them as having, in the Ctenophora, their origin in the ctenophoral vessels, that is to say, from the endoderm; in the Triclades they are developed from the enteric epithelium, so that the homology would appear to be complete.

The excretory organs of the Ctenophora are regarded as being represented by those pores by means of which the branches of the vessel of the funnel are brought into relation with the outer world; in *Gunda* it consists of large canals, which anastomose with one another, and of a number of fine excretory capillaries which are considerably branched, but which do not anastomose. The large canals here and there give off large branches to the dorsal surface of the body without opening into contractile vesicles. Throughout the whole body of the animal there are scattered a number of smaller or larger vacuoles, which have a considerable resemblance to the contractile vesicles of the Infusoria. These vacuoles are not arranged irregularly, but are united into small groups, and when one of them is examined, we see that it is supplied by a branch from the excretory capillaries, and there is a ciliated band between the vacuoles. A fact, to which the author attaches much importance, is the presence of a large number of ciliated infundibula in and on the epithelium of the branches of the enteron. The vacuoles which surround the funnel cannot be distinguished from those which are found in the enteric cells; the protoplasm of the ciliated funnel is the plasma of an enteric cell, and the funnel is a hollowed endodermic cell, ciliated within. The homology between these structures and the protoplasmic networks to which they give rise, with the intercellular lymphatic plexus of Fraipont and Francotte, and the subcutaneous nerve-plexus found by Ihering in *Graffilla muricola* is insisted on, and it is found that, taking all the characters into consideration, they must be regarded as being formed on the same type as those of the Cœlenterata.

The musculature of the Polyclades arises from the four primitive cells of the mesenchyma; the cells which are to become muscular fibres are arranged in layers under the epithelium, and their arrangement, like the mode of locomotion, is different to that which is seen in the Cœlenterata, but it is to be explained as due to their creeping mode of life, which demands a more regular distribution of the fibres, and a greater development of the superficial muscles.

Our space will not allow us to follow the author into the comparisons which he institutes between *Gunda* and the fresh-water Triclades, or the Hirudinea; he finds, however, that the Leeches are closely allied to *Gunda;* and dealing with *Trochosphæra*, he points out that all larvæ of its type are only provided with organs which are,

physiologically, most necessary to it; by means of these partly provisional organs, the larva seeks its food, and the material for afterwards developing its body; in other words, the trochosphere does not represent the whole body of a Platyhelminth, but merely the cephalic portion of *Gunda*, with a fresh structure, the anal segment.

Echinodermata.

Nervous System of the Ophiuroidea.*—N. Apostolides, who has already† examined and described the circulatory and respiratory organs of this little-studied group, says that the circum-oral nerve-ring is contained in a "perineural" space which forms part of the body-cavity, and communicates with the general body-cavity at the point of entrance of the radial nerves into the arm; the space is triangular in transverse section, and is bounded on the outer side by the second discoid ossicle of the skeleton, and above and below by two membranes which originate in the point of union of the stomach and œsophagus, and are inserted on the ossicle. The nerve-ring itself forms a vertically flattened band. The radial nerves pass off from it horizontally, each traversing the foramen in the second discoid ossicle; each then turns upwards as far as the ventral plate, when it again becomes horizontal and then traverses the furrow of the arm. The annular canal of the water-vascular system and its branches lie outside the corresponding parts of the nervous system. Histologically, the nerve-band consists of two distinct tissues, the one ventral, consisting of brown cells with large nuclei and not coloured by picrocarmine; they have been wrongly regarded by most writers as constituting the essentially nervous element, but they resemble rather the pigment-cells of Vertebrata. The dorsal portion of the band is the true nervous part; it forms a very small portion of the whole band, and lies in a groove on its superior aspect; it consists of extremely delicate fibrils, between which pale bipolar cells lie scattered, not aggregated into ganglia.

The radial nerves exhibit certain dilatations opposite to intervals between the ossicles, but they are composed of the same non-nervous matter as that of which the ventral part of the ring consists. No branches are given off by the central ring, but the radial nerves give off from their origin a pair of nerves, the upper one of which goes towards the first tentacle and, when near it, divides; the two twigs thus formed course round the end of the tentacle and meet on the opposite side of it. The exact distribution of the nerve in the walls of the tentacle is unknown. The lower of the branches of the radii goes towards the muscles which lie between the angles of the mouth. Two similar pairs of nerves are given off by the radial nerve before it reaches the arm and another pair within the arm, all having the same distribution as the first pair.

American Comatulæ.‡—In his preliminary report on these forms Mr. P. H. Carpenter states that he thinks he has discovered as many

* Comptes Rendus, xcii. (1881) pp. 1424–6.
† See this Journal, i. (1881) p. 466.
‡ Bull. Mus. Comp. Zool. Camb., ix., No. 4 (1881) 20 pp. (1 pl.).

as forty new species in the collections dredged in the Gulf of Mexico and the Caribbean Sea. Nearly all were obtained from depths less than 200 fathoms; new and very singular types were obtained on the three occasions when Comatulæ were brought up from more than 300 fathoms. As very similar conclusions are to be drawn from the 'Challenger' collection, it seems that Comatulæ are essentially inhabitants of shallow water. When we compare the two collections it is interesting to see how they supplement one another. Ten-armed forms abound in the Caribbean, while in the eastern seas the majority have the rays always dividing, in some cases as many as seven times. The characters of several little-known species are discussed, and *Antedon spinifera* n. sp., and *Actinometra pulchella* Pourtalès are described in detail. Attention is again directed by the author to the characters which distinguish the genera *Antedon* and *Actinometra*, and these are usefully summarized in a table.

Two Pentacrinoid forms were found entangled in the arm of *Act. meridionalis*, and are presumably the young of that species; if so, they are probably the first Pentacrinoid Actinometræ that have been observed: a study of these specimens and of young Antedons leads to the belief that the late appearance, as a whole, of the basal pinnules is a "marked developmental character among the Comatulæ." This is of interest in connection with Mr. Carpenter's account of a new genus *Atelecrinus*, in which the basal circlet is complete in the adult as it is in some Pentacrini, and the earlier stages of Pentacrinoid larvæ. In the characters of its calyx this new genus retains permanently larval characters; so, too, there is an absence of pinnules from the lower part of the arm. *Ant. cubensis* with the new species *A. balanoides* will belong to this genus.

Cœlenterata.

Characters of Stinging-cells of Cœlenterata.*—Dr. C. Chun recalls the fact that late investigations have directed attention to the nature of the processes which connect the stinging-cell with the supporting lamella ("mesoderm"); Claus has regarded them as muscular fibres, and the brothers Hertwig as nervous structures. If we examine their mode of termination we find that they may or may not pass into the ectodermal longitudinal muscles of the tentacles. Observations tending to the conclusion that the processes in question are representatives of muscles are confirmed by the examination of *Physalia*, for in this Siphonophore it is to be observed that hundreds of muscular lamellæ arise, with extraordinary regularity, from the muscular band which passes to some of the filaments; the vessel running through the middle of the band gives off, under each battery of stinging-cells, a widening branch, the endodermal cells of which are remarkably increased in size beneath the battery. In other words, we find in *Physalia* a mesoderm well developed and traversed by cellular elements. The rounded nettle-capsules of each battery may be small or superficial, or larger and deeper. The stalks of the

* Zool. Anzeig., iv. (1881) pp. 646–50.

small stinging-cells are distinctly transversely striated; in the case of the larger cells we find that the stalk contains in its centre large oval nuclei, the contractile substance is broken up into 8–12 transversely striated fibrils placed at regular distances from one another; at the level of the capsule these branch dichotomously, and at the end where the cnidocil is placed we find a large number of fine contractile fibres converging in a regular manner, and at regular distances.

Now that the connection of muscles with the stinging-cells has been made certain, it is easy to see what is the real nature of the pressure on the wall of the capsule, which has been universally recognized as necessary for the protrusion of the spiral filament. When the network of fibrils contracts there must be a certain pressure on the wall; where this network is absent, the contraction of the stalk must press the capsule against the tissues which underlie it; and both causes may act, as in *Physalia*, at the same time. As to the irritability of the muscles it is to be noted that the necessary connection of the muscular stalk with nervous elements has so far been worked out by Chun in *Physalia* that ganglionic cells have been there observed, and that sensory hairs are always richly developed in the region of the urticating batteries.

Morphologically, the stinging-cells appear to represent not glands, the secretion of which forms the capsule, but epithelio-muscular cells.

Development of the Cœlenterata.*—In these comparative embryological studies E. Metschnikoff considers the formation of the endoderm in the Geryonida, and the development of the *Cunina* parasitic in *Carmarina.*

In dealing with the former, the author refers to the doubts expressed by Professor Haeckel as to the reality of the delamination method of the formation of the gastrula; and relates how in *Carmarina fungiformis* he was able, at the stage of the formation of thirty-two blastomeres, to separate the finely granular ectoplasm from the wide-meshed endoplasm; most of the cells were seen to be dividing, and this process of division was best marked in the nuclear spindle. Those that divided radially gave rise to new blastodermal elements, while others which divided tangentially separated the endoderm from the ectoderm. In a second form, *Liriope eurybia*, the delamination-process was most clearly observed, some of the blastodermal cells grew deep into the cleavage cavity, the nuclei were seen to be dividing; when the cell protoplasm was constricted the ectoplasm was almost exclusively found in the peripheral and the endoplasm in the central segment. This process was succeeded by the formation of a separate endodermal layer and then of a diblastula.

Dealing with the *Cunina* parasitic on *Carmarina* the author examines the accounts of the formation of the gastrula in the *Hydromedusæ;* and in giving a description of his own observations states that the youngest form examined by him formed a small white dot on the margin of the umbrella of *Carmarina fungiformis;* under the

* Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 433–44 (1 pl.).

Microscope it was seen to be a rhizopod-like organism with a rounded cap; that is to say, the larva proper contained a colossal amœboid cell and a bell-shaped covering of flagellated epithelium. The large cell gave off a number of homogeneous processes, many of which branched or were flattened out at their free ends. Within there was a large nucleus, closely resembling the central capsule of many Radiolaria, and this was invested in an elastic membrane, and had finely granular contents. This large cell is the body which was spoken of by Uljanin as the finely granular mass within the gastric cavity. The further stages of development are characterized by the overgrowth of the colossal amœboid cells by the flagellated cells, and the consequent formation of the oviform larva, which Uljanin regards as the starting-point of his invaginate archigastrula; but the author points out that there is in it no round blastopore, but only a fine slit; this does not serve for the ingestion of nutriment but only as a means of passage for the pseudopodia of the enclosed colossal cell. The larvæ, increasing in size, become elongated, and often triangular in form; the ectoderm is sharply separated from the endoderm, and consists of a single layer of delicate flagellated cells; while the endoderm forms a single layer of cylindrical-flattened cells.

Gemmation commences even at this stage, a longitudinal section revealing a diminution of the two germinal layers at the point where the mouth of the first Medusa appears later on; a well-marked projection at the oral pole forms the proboscis of the first Medusa-bud. In later stages we find that the colossal cell is long persistent; the first sign of degeneration would appear to be the appearance of several—perhaps renal—concretions; later on this degeneration becomes gradually complete.

The author is of opinion that the whole life-history of this parasitic Medusa presents a series of secondary adaptations, which are in causal connection with the parasitic habit; the alternation of generations is of a secondary nature, and the asexual generation is characterized by the loss of the genital organs and of a number of the other organs of a Medusa.

Nervous System of Hydroid Polyps.*—C. F. Jickeli states that he has discovered nervous elements in these, the only Cœlenterata in which they have not yet been observed. In the arms of the hydranths of *Eudendrium*, he found between the flat ectodermal cells and the longitudinal muscular fibres, branched cells, whence processes pass off to a number of urticating cells, or become lost between the muscular fibres; there is also a direct connection between the ganglionic cells. He asserts the existence of a nervous plexus which is continued forwards to the hypostome, and which extends also into the hydrophyton. Near the circlet of glandular cells at the base of the hydranths there is a larger collection of ganglia; but the connection by nerve-fibres between the two was not made out. The nervous system would appear to be confined to the ectoderm.

* Zool. Anzeig., v. (1881) pp. 43–4.

Remarkable Organ in Eudendrium ramosum.*—When engaged in his investigations into the mode of origin of the generative products of this hydroid, Dr. A. Weismann observed remarkable outgrowths on the head of the hydranth, of which, at first, he took no especial notice, as he regarded them as pathological products. They are horn-shaped stout processes growing out laterally from the head of the polyp; in form, though not in dimensions, they resemble a tentacle, with the exception that they are not thinner, but, as a rule, swollen at their free ends; they are formed by the two body-layers, and contain a continuation of the body-cavity; they are not found on all the hydranths of a colony, and this might lead us to think that they are degenerated structures; that, however, they are not degenerated gonophores is shown by the fact that, while all gonophores arise below the circlet of tentacles, or in the upper half of the hydranth, these are always developed below the hydranth; again, their structure shows that they have a definite function, they are actively motile, have a well-devèloped muscular layer, and are so remarkably well provided with urticating organs that they might be spoken of as cnidophores.

If we enter into the details of their structure, we find that the ectoderm only differs from that of the hydranth in its much richer supply of urticating organs; while there is nothing remarkable in the supporting lamella, there are, in addition to the epithelial cells of the endoderm, subepithelial cells lying on the supporting membrane and giving origin to circularly arranged muscular fibres: as yet circular muscles have only been observed in *Tubularia* among the Hydroid Polyps. In *Eudendrium* the circular muscular layer of the cnidophores is strongly developed and consists of very fine long fibres, which frequently exhibit a delicate transverse striation. After this description it can hardly be doubted that we have to deal with an offensive organ; the power of active movement, and the notable supply of stinging organs of colossal size sufficiently demonstrate the correctness of this view of their function.

The cnidophores always arise from a circular but indistinct wall of ectoderm, which is separated off by a circular groove from the wall of the stalk; this groove may be known as the glandular ring, and the wall as the urticating wall. In the region of the former the ectoderm cells are in one layer only, or, the glandular cells reach to the surface.

Viewed morphologically, the cnidophores are seen to be processes of the body-wall; in their earliest stages they are blunt, broad, solid processes of the urticating wall developed by a thickening of the ectoderm. In the next stage they contain an endodermal process, and thence to the complete condition there is every kind of intermediate stage. It is important to note that they only arise on developed hydranths, for this shows that they are, phylogenetically, relatively young organs. Their presence on some hydranths only presents some difficulties, and we can only suppose, till they shall have been studied during life, that they are developed as a protection against

* MT. Zool. Stat. Neapel, iii. (1881) pp. 1–14 (1 pl.)

some special kind of enemy. If it be true that they are not found on other species of the genus, we shall have another proof of their late development in time; their great size has prevented their development in large numbers on the same person, and may be the explanation of their asymmetrical character. No organ known in any other Cœlenterate can be compared with them, with the exception of the nematophores of the Plumularida, in which there is a process continued from the endoderm, though one that is only feebly developed. Three kinds of offensive organs seem, therefore, to have arisen independently of one another, for in the Hydractinidæ they are represented by the so-called spiral zooids.

Siphonophora of the Bay of Naples.*—M. Bedot finds that the Bay of Naples is one of the richest of all parts of the Mediterranean for these interesting forms; in one season he found 17 species, and altogether he knows of 19; all the families of the order are represented, and *Physophora philippii*, *Forskalia contorta*, *Halistemma rubrum*, *Praya diphyes*, and *Diphyes quadrivalvis* are very abundant. Of the last-named form the author had some specimens 60 cm. long, and he once observed an abnormal example, with three swimming-bells.

Ctenophora of the Bay of Naples.†—A very complete abstract of this monograph by the author, Dr. C. Chun, will be found at pp. 193–5, and 212–26 of Part 1 of the 'Zoologischer Jahresbericht' for 1880.

Protozoa.

Symbiosis of Lower Animals with Plants.—Yellow Cells of Radiolarians and Cœlenterates.—See *infra*, Botany, Algæ.

New sub-class of Infusoria—(Pulsatoria).‡—Three years ago Mr. P. Geddes described § some curious cells which occur in large numbers in the mesoderm of the Planarian *Convoluta schulzii*. The cells are a little smaller than the red blood-corpuscles of the Frog, are nearly in the form of a slightly curved pear, and have a large central vacuole, filled with fluid. On the wall of this cavity, and towards the more convex side of the cell, almost parallel with its principal axis, there is a row of homogeneous and transparent fibrillæ which are inserted at their upper and lower extremities in the ordinary protoplasm of which the other parts of the cell is composed. This differentiation into a granular and fibrillar part is comparable to that which takes place in the embryonal muscular cells of the Tadpole, and recalls somewhat the structure described by Lankester in the heart of Appendicularia. If these cells are examined free in sea-water it is seen that they are in a state of rhythmical contraction, the rapidity and vigour of which are equally surprising, the most active pulsating from 100 to 180 times per minute; each

* MT. Zool. Stat. Neapel, iii. (1881) pp. 121–3.
† Fauna u. Flora des Golfes von Neapel, Mon. I. pp. xviii. and 313 (22 figs. and 18 pls.).
‡ Comptes Rendus, xciii. (1881) pp. 1085–7.
§ Proc. Roy. Soc., xxviii. (1879) p. 449.

time the principal axis becomes more strongly curved, and the cell shorter and broader. This change of form depends exclusively on the contraction of the inner fibres, the other parts of the cell remaining quite passive. The movements of the cells soon begin to slacken, become irregular and feeble, finally cease, and the cell bursts. Its protoplasm soon perishes, but the fibres resist for a longer time the action of the water, and even exhibit a trace of contractility like dying cilia.

Numerous observations have convinced Mr. Geddes that these cells are in reality parasites. Other species of Planarians possess nothing like them. The delicacy of their protoplasm distinguishes them from the true tissue of the *Convoluta.* Moreover, they do not form tissue, and have no definite disposition. Regarded as parasites, their structure, apparently so abnormal, is readily derived from the type of ordinary Infusoria by the suppression of the cilia (which would not be available for locomotion among the cells of the mesoderm) and the differentiation of the contractile vesicle.

This differentiation is certainly very remarkable from every point of view when we consider the relatively enormous size of the vacuole, the development of the contractile fibres which limit it, or the rapidity of their contraction.

The author proposes to call this Infusorian *Pulsatella convolutæ*, and as it is so distinct from either Suctoria, Ciliata, or Flagellata, to create for it a fourth sub-class Pulsatoria.

Skeleton of the Radiolaria.*—Professor Bütschli deals especially with the *Cyrtida*, having had the advantage of studying a number of fossil specimens from Barbadoes. He commences with a study of *Cœlothamnus* (?) *davidoffii* n. sp., a Phœodarian in which the skeleton is as much as $1\frac{1}{2}$ cm. in diameter. Examined with the naked eye, it is seen to be a (marine) organism, stellate in form, with sixteen relatively long rays, which appear to arise from a common centre. These rays are skeletal parts, and are, with the centre, imbedded in a common gelatinous mass. Belonging to Haeckel's family Cœlodendrida, its exact generic position must still remain a matter for discussion. The central portion is formed of two separate valves, which resemble one another in their structure, though not in their form. The details of their characters and of their connection with the rays is given.

The structure and relations of the Acanthodesmida, Zygocyrtida, and Cyrtida (Cricoidea: Bütschli) are then dealt with in detail; and the author concludes by pointing out that he cannot regard as natural Haeckel's division of the Cyrtida into Mono-, Di-, and Sticho-cyrtida. He can only distinguish two separate phyla, but he is careful to point out that our knowledge of these forms is at present very slight.

Recent Researches on the Heliozoa.—L. Maggi † has observed on a *Spirogyra* a form belonging to Cienkowski's genus *Nuclearia*, and,

* Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 485–540 (3 pls.).

† Rendic. R. Istit. Lomb., xiii. (1880) fasc. 20. Cf. Zool. Jahresber. Neapel for 1880, i. pp. 154–5.

considering it, on account of its having two nuclei, to be a new species, assigns to it the name *N. duplex.* This species undergoes encystation occasionally, like the other *Nuclearicæ*, and during the process Maggi saw the two nuclei increase by fission to four. Then followed the division of the envelope of the cyst, in such a way that one of the portions into which it divided enclosed the old nuclei, and the other the newly-formed nuclei. This bi-nucleate *Nuclearia* the author believes himself justified in regarding as exhibiting a most important phylogenetic step towards the bi-nucleate condition shown by the fertilized ovum in the simultaneous occurrence of a male and a female nucleus, and finds the explanation of this doubly-nucleate developmental stage of the Metazoan ovum to lie in the existence of a phylogenetic bi-nucleate Protozoan predecessor of the character here described.

G. Cattaneo,* after a short historical survey of the investigations which have been made among the Heliozoa, describes his observations on *Acanthocystis flava* Greef, made on a single specimen in the course of two mornings. As might have been expected, he has but few facts to show, although the conclusions which he strives to draw from them are none the less far-reaching. He cannot regard the external, vitreous, colourless protoplasmic zone of *A. flava*, which has been described as ectosarc by various authors, as such, but considers it to be what he terms *mesoplasm.* The reasons for this opinion are that it contains the contractile vacuole, and sends out the fine pseudopodia which serve only as organs of prehension, these being the characters of the mesoplasm, as elaborated by Maggi in the case of *Podostoma*, &c. The ectoplasm proper of the present form, *Acanthocystis,* is said to be developed into the silicious skeleton, which cannot be regarded as a product of excretion of what is usually called mesoplasm. The author finds a confirmation of this view in the relations of the parts of the so-called chlamydophorous *Heliozoa*, in which the ectoplasm proper is still to be found in the condition of an external envelope, while further on in the developmental history of *Arcella vulgaris*, as described by him, he finds that the ectoplasm which is present in the young stages developes later into the shell.† The author, of course, extends this view as to the nature of the investing skeleton to all the Heliozoa which have skeletons.

Cattaneo also states that he has observed the following. The simple central nucleus, said to possess a deeper brown coloration than the investing entosarc, was divided by a constriction after its nucleolus had become double. One half of the nucleus remained in the centre, while the other wandered to the surface of the entoplasm. Brown granules then became developed in numbers, and were finally scattered through the entosarc; they are regarded by the author as spores. From this observation he believes it necessary to doubt the occurrence of simple fission under any form in such highly-developed

* Atti Soc. Ital. Sci. Nat., xxii. (1880) p. 46 (1 pl.). Cf. Zool. Jahresber. Neapel for 1880, i. p. 155.

† Professor O. Bütschli remarks (Zool. Jahresber. Neapel for 1880, i. p. 155) of this observation, that it justifies an opinion expressed by himself in Zool. Jahresber. Neapel for 1879, as to the probability of an origin of this kind for the shell of *Arcella.*

Protozoa as the *Heliozoa.* In them reproduction takes place by polysporogony; in the Thecolobosa also the ordinary method of reproduction is the generation of numerous germs in the entoplasm. He endeavours to derive the buds observed by R. Hertwig in *Acanthocystis aculeata* from such internal spores as these whose existence he assumes. Naturally, the formation of swarm-spores observed in *Actinophrys* and *Actinosphœrium* by Greef and Archer appear to him to support his explanation. He explains the feeble phenomena of motion exhibited by *Acanthocystis flava* as not caused by the pseudopodia, but as due to the mobility of the skeletal elements and to slight dislocations of the surface of the body.

Dimorpha mutans.*—Dr. A. Gruber regards this form as being intermediate between the Flagellata and the Heliozoa; he points out that the systematic position of the former has been a matter of much difficulty, but that Stein is probably right in associating them especially with the Infusoria. With regard to their mode of locomotion, it may be pointed out that in the Protozoa we may have a streaming of protoplasm, the action of flagella, or ciliary movement; there are no fundamental differences between these modes, and in some cases more than one is to be seen in one individual; among these is the organism here described. At one moment appearing to be an *Amœba radiosa*, it suddenly seemed to shoot out a long flagellum on one side; the body then elongated and became oviform, while the pseudopodia began to shorten: two flagella were now seen. After moving about, it suddenly stopped, became spherical, and gave off radially fine pseudopodia, so that it looked like a *Heliozoon.* The cycle of change was again repeated, and was observed in numerous specimens.

The swimming movement is always connected with a rolling round the long axis, which renders observation somewhat difficult; it was, however, possible to see that the margin of the body was often quite smooth, so that it resembled a monad; the protoplasm at the anterior end is then much clearer and free from granules, while the middle portion is dark and contains larger crystalline corpuscles. The nutrient material is collected at the hinder end of the body. There are always two flagella, arising near one another at the anterior blunted pole. No mouth could be seen, and the dark protoplasm completely obscured the nucleus. There is a large contractile vacuole, but there is no cuticle. The pseudopodia would appear to be what Engelmann has called *myopodia*, or to present a fibrillar structure; when a spore of an alga is seized between two pseudopodia, it is almost immediately killed; it is carried to the periphery of the mass of the body and is seized by a broad protoplasmic process, just as in an Amœba; as this may take place at two points of the body simultaneously, it is clear that there is no part specially set apart for the ingestion of nutriment. In four hours digestion is completed. The general protoplasm is soft and not very consistent. On the whole *Dimorpha* presents the characters of a true Heliozoon, but in

* Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 445–59 (1 pl.)

addition, the two flagella never completely disappear, however much they may be hidden from view; nor is the body perfectly round. The study of its developmental history was, unfortunately, only incompletely carried out.

The author concludes by discussing the doctrine of Bergh that the Cilio-flagellata are the lowest forms; to this he cannot give his adhesion, believing rather that the Rhizopoda stand nearest to formless plasmodia.

Contributions to the Knowledge of the Amœbæ.*—Dr. A. Gruber points out that Auerbach,† starting from the assumption that a membranous boundary was a necessary attribute of a cell, set up a theory, according to which the Amœbæ also, as unicellular creatures, had a membranous envelope. This opinion was refuted by subsequent naturalists, principally Greeff,‡ but with its overthrow some forms of *Amœbæ* and many of the phenomena of their sarcode body, well known to Auerbach, although not quite rightly interpreted by him, seem to have been lost sight of.

The existence of a fine layer of clear protoplasm round the *Amœba* body, which must be penetrated by the pseudopodia, is by no means an insignificant phenomenon, and the author therefore considers it useful to describe another *Amœba* of the same kind (*A. tentaculata*), and to reinvestigate Auerbach's *A. actinophora.*

1. *Amœba tentaculata* sp. n. was found in a small sea-water aquarium, the water and organisms being chiefly derived from the Frankfurt aquarium, but mixed with some from the Baltic and Mediterranean.

It forms a little mass of very variable size, 0·03 mm. to 0·12 mm. In consequence of its greater refractive power, the body stands out luminously from the water, a property which in the protoplasm of all Rhizopoda goes hand-in-hand with greater viscosity. We find the rule confirmed here, for the protoplasm of *A. tentaculata* is, in fact, an extremely tenacious mass, in comparison with that of allied creatures.

Under a power of 80 we can see no movement or change of form, and it is only with high and very high powers that we can recognize an *Amœba* in continual although sluggish change.

Examined in the resting state, it has essentially the same form as *A. verrucosa*; i.e. the whole body is shrunk together, and covered with elevated knobs and deep folds which slowly change their form and position.

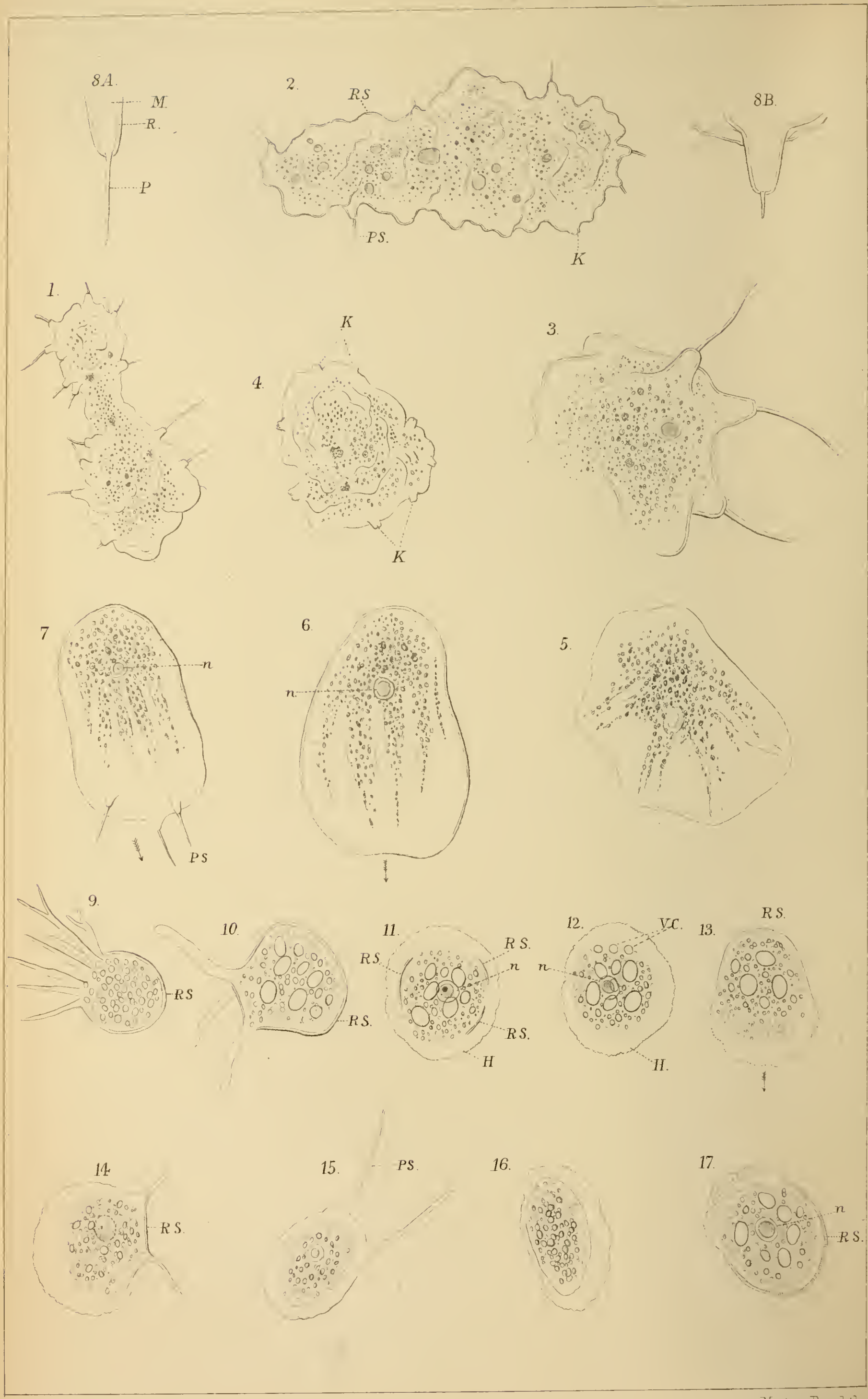
In the interior the vital activity of the protoplasm is manifested by a streaming and trembling movement of the fine dark granules with which the sarcode is abundantly furnished.

But while in *A. verrucosa* we miss true pseudopodia, both in the resting state and during flow, we are surprised here by seeing fine

* Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 459–70 (1 pl.). See Ann. and Mag. Nat. Hist., ix. (1882) pp. 106–16 (1 pl., the use of which has been obligingly allowed us by the publishers).

† "Ueber Einzelligkeit der Amöben," Zeitschr. f. wiss. Zool., Bd. vii.

‡ Greeff, 'Ueber einige in der Erde lebenden Amöben und andere Rhizopoden.'



Mintern Bros lith.

Amœba tentaculata 1-8
— „ — actinophora 9 17.

protoplasmic filaments at different parts of the body. There are three processes of equal breadth throughout which stand out from the body, sometimes in one place, sometimes in another, and bend to and fro as if feeling about, often curved, but generally pretty straight. At first it seemed that these pseudopodia did not, as in other *Amœbæ*, spring from the protoplasmic body in the shape of fingers gradually becoming thinner, but that small conical elevations of the body served as their base, and that they rose from these with a distinctly marked separation. When they were very numerous they gave the *Amœba* a very peculiar appearance (Pl. III. Fig. 1).

With a Hartnack No. X. (or Seibert's homogeneous immersion) the whole *Amœba* proved to be enveloped by a fine layer of denser substance, a membranaceous cortical layer which causes the periphery of all its humps and processes to appear distinctly double-contoured.

Directly within this firmer envelope lies the soft internal sarcode-mass. If a pseudopodium is to be pushed forth, the enveloping layer must first be broken through. This, however, offers some resistance, and is consequently pushed out in a conical form. An aperture is broken through at the apex of the cone, and the sarcode issues in the form of a thin filament (Fig. 8). The retraction of the pseudopodium was very distinctly observed, after which a new one frequently issued from the same cone.

The pseudopodial cones have a very constant form, and although they can obliterate themselves again completely, this does not always take place after the retraction of the pseudopodium; but very frequently the elevation remains, and a small crater seems to have been formed where the pseudopodium was emitted (Fig. 2 *k*). One specimen had many cones, but all without processes (Fig. 4 *r*), nevertheless they persisted without alteration for a considerable time.

Whether the pseudopodia act as tactile organs or bring in food, cannot be definitely stated. The former, however, appears to be more probable, for in the interior are nutritive materials, such as diatoms, algæ, &c., much too large to be capable of penetrating through the narrow aperture of the cone.

At any rate the animal, notwithstanding its firmer enveloping layer, is able to take in solid materials. Moreover, we know very nearly allied forms such as *A. verrucosa*, which are destitute of these organs, and nevertheless take in such nutritive bodies. Sometimes it appeared as if a slow locomotion was effected by means of the pseudopodia, but only to very inconsiderable distances.

In advancing, *A. tentaculata* employs no special organ any more than its allies which possess a firm cortical layer. The humps and folds gradually disappear, the pseudopodia are for the most part drawn in, and with them the cones, and after the surface has become smooth, there commences a steady flow in one direction, exactly in the same manner as has long been known in *A. verrucosa*, although much slower. In the latter this stage was for a time regarded as forming a distinct species under the name of *A. quadrilineata*.

The longitudinal folds which gave the name to the latter, and

which are produced by the strain on the tenacious outer layer acting in one direction, occur here also (Figs. 5, 6, and 7). Along them we see the granules hastening forward in several streams, whilst a clear mass of protoplasm, free from granules, in constant flow, moves on before them. A remarkable circumstance is that on the leading part of the body, pseudopodia with their cones frequently persist, and thus to a certain extent may act as extended feelers (Fig. 7).

While at the end opposite to that which is pushing forward the double contour is distinctly preserved in the outer layer, it disappears entirely on the anterior part (Fig. 6), from which it seems that the first mentioned part of the body retains its toughness, whilst anteriorly all becomes in flux, i. e. the more fluid constituents collect there. Nevertheless, even these still have considerable density, as is proved by the pseudopodia and pseudopodial cones protruded from them, on which, however, no double contour is visible. Frequently a zone of clear protoplasm seems to surround the whole body, and then the double lines are no longer seen anywhere.

EXPLANATION OF PLATE III.

Fig. 1.—An *Amœba tentaculata* with many pseudopodia.

Fig. 2.—Another, 0·12 mm. long, under a higher power (Hartnack eye-piece 3, objective 10 immersion). It shows the cortical zone (*r s*), the pseudopodia (*p s*) on their cones, and at *k* a cone of which the pseudopodium has been retracted (crater).

Fig. 3.—A portion with three pseudopodia highly magnified.

Fig. 4.—A specimen with a number of craters (*k*).

Fig. 5.—A specimen in which the cortical zone is dissolved.

Fig. 6.—A flowing *A. tentaculata*, in which the nucleus (*n*) is very distinctly visible.

Fig. 7.—Another, in which three pseudopodia (*p s*) are still retained on the advancing part.

Fig. 8a.—A pseudopodium with its cone. *m*, the soft interior mass; *r*, the cortex; *p*, the pseudopodium.

Fig. 8b.—A pseudopodium in course of being retracted.

Fig. 9.—An *A. actinophora*, with a distinct cortical layer (*r s*) and a tuft of pseudopodia at one end (Hartnack eye-piece 3, objective 7).

Fig. 10.—Another, with few pseudopodia, distinctly showing how they break through the cortex. (Rather too large in proportion to the following figures.)

Fig. 11.—The same example a short time afterwards. The cortex (*r s*) is almost everywhere liquefied, and has become converted into a clear space (*h*); *n*, the nucleus which is distinctly visible in this state.

Fig. 12.—The same, with the cortex completely dissolved; *v c*, contractile vacuoles.

Fig. 13.—The same, in slow flow in the direction indicated by the arrows; *r s*, the newly reconstituted cortex.

Fig. 14.—Another example, in which the cortex has just become liquefied, but it is still retained at one spot together with two pseudopodia.

Fig. 15.—An *Amœba*, in which the cortex has dissolved before two pseudopodia (*p s*) were retracted. These became liquefied soon afterwards. In this and

Fig. 16 the granular protoplasm is sharply separated from the hyaline zone. This, however, only lasts for a few moments to give place to the state in Fig. 12.

Fig. 17.—An *Amœba*, in which the liquefaction of the cortex has just commenced on one side, treated with osmic acid. The cortex (*r s*) appears finely punctuate, as also the hyaline sarcode; the nucleus at *n*.

Of a nucleus nothing is to be seen in the resting state when the folds obstruct the view of the interior. But if the Rhizopod begins to move when the body flattens, the nucleus becomes distinctly visible (*n* in the figures), as a little disk surrounded by a narrow border, as in most Amœbæ. No contractile vacuole is present, a new proof of the still unexplained fact that this structure is wanting in the marine Rhizopoda.

2. *Amœba actinophora* Auerbach is very small, measuring 0·03–0·04 mm., occurring pretty plentifully in all sorts of receptacles of water in the neighbourhood of Lindau. It is exceedingly suitable for the completion and elucidation of the previous observations.

The first striking point is, that here also the protoplasm is distinctly surrounded by a double contour, the animal appearing as if covered by an envelope. The periphery is for the most part perfectly smooth, and only at one point does the animal extend a larger or smaller number of lobate pseudopodia. In this way the *Amœba* acquires delusively the appearance of a thalamophorous Rhizopod with a closely fitting thin carapace, from the orifice of which processes protrude (see Fig. 9). In this condition the protoplasm in the interior forms a tolerably compact mass, in which there are a number of rather strongly refractive granules.

When the number of the pseudopodia is large, so that a whole tuft of them protrudes at once (Fig. 9), we see nothing of the cortical zone at their place of issue. It is otherwise when only two or three processes are pushed forth. The relations of the marginal layer are then quite distinctly visible, and we find that, just as in *A. tentaculata*, the cortex is pushed out into a cone at the apex of which the pseudopodium makes its way out. Here, therefore, the double contour is also produced by a more tenacious layer surrounding the animal, which must be penetrated by the protoplasmic processes before they can issue (Fig. 14). Even in the previously described form, however, we saw that we have not to do with a persistent membranous structure, but that during the flow of the animal the cortical layer becomes amalgamated with the rest of the sarcode. This is much more distinctly observable in *A. actinophora*. Thus all at once we see how, as the animal changes its form, the pseudopodia are at the same time nearly all retracted, the body becomes flattened, the cortical zone vanishes, and flows into a broad border of clear protoplasm, which surrounds the darker richly granular mass in the centre of the animal (Figs. 11 and 12 *h*). The latter often remains for some time sharply discriminated from the hyaline border (Fig. 17), but the boundary is soon obliterated, exactly as during the formation of an ordinary pseudopodium (Fig. 12). In this state the nucleus (*n*) also becomes distinctly visible, agreeing precisely in its structure with those of other *Amœbœ*.

The melting of the fine cortical layer into the broad clear border does not take place with equal rapidity at all points, so that a part of the *Amœba* often appears sharply limited, whilst another is already surrounded by the clear space (Fig. 11 *r*, *s*). In Fig. 14, for example, is represented an *A. diffluens*, one side of which is already quite

liquefied, while on the other half the double contoured enveloping layer is still retained, and on it even two pseudopodial cones with the processes issuing from them are still visible. Fig. 15 is also instructive in another way. There the cortical layer has become fluid, and we see that the two pseudopodia which have persisted, consist of the same hyaline protoplasm as the clear border in which the cortical zone previously sharply separated from it (Fig. 14), has dissolved itself. In the first state, therefore, there would have been an envelope and an endoplasm enclosed by it, and from which the pseudopodia proceeded clearly distinguishable; in the latter, both have become fused into one. Rapidly as the broad, scarcely visible border had formed, it can just as rapidly contract itself again; it shrinks to a certain extent together, until the narrow cortical layer again originates from it.

In this way *A. diffluens* can continually change its aspect completely in one or other of the modes described. Upon what law this power depends cannot be stated definitely; very probably, however, different conditions of pressure come into play in the matter. With a centripetal pressure acting uniformly upon the whole periphery, the more fluid parts of the protoplasm are all pressed into the interior, and only the narrow membranaceous boundary remains. This acquires a firmer consistence by contact with the water, and therefore at the points where pseudopodia issue, it is pushed aside by the latter. If the general pressure ceases, the more fluid constituents again come forth from the interior, dissolve the solidified cortical layer, and form the clear border.

The best illustration of this explanation of the process is furnished by those cases in which a slow flowing forward of the *Amœba* in one direction is taking place (Fig. 14). On the advancing side the fluid constituents are pushed on in front; here all pressure has ceased whilst it acts upon the opposite side, where accordingly the cortical contours are quite distinctly to be seen.

Auerbach had also observed this liquefaction into a disk as is shown by his Fig. 8, but he conceived of it as a phenomenon of expansion in which the cell-membrane also had to take part, but we know that no such membrane exists, and that the envelope is to be regarded only as a transitory concentration of the outermost layer of sarcode, and can at any time dissolve again (Fig. 11).

Dealing with *Cochliopodium pellucidum* of Hertwig and Lesser, the envelope of which represents a true carapace, the author points out that "a perfecting of this structure may be demonstrated from *A. tentaculata* through *A. actinophora* to *Cochliopodium*. It might be conceived that by a further increased tenacity of the cortical zone we shall finally be led to those forms of monothalamous Rhizopods whose envelope forms only a soft membrane closely embracing the sarcode, and which is still so completely at one with the protoplasmic body as to accompany it in all its movements and to be constricted simultaneously in the division.

"Glancing back once more upon the phenomena which confront us in the Amœbiform Rhizopods surrounded by a distinct cortical

zone, we shall find in them a welcome elucidation of conditions such as have only been guessed at in the case of other *Amœbæ.*

"In the sarcode body more and less fluid constituents are present; the former we find at the spots which betray a centrifugal movement whether in the pseudopodia or in the advancing part of the flowing Amœbæ (*A. quadrilineata*, *villosa*, *tentaculata*, &c.). The heavier constituents remain behind and are dragged along, and we see them finally break into many cushion-like processes of hyaline protoplasm.

"The pushing forward of the more fluid constituents is effected by the action of pressure upon the opposite side; this is produced by the outermost layer of protoplasm at this part acquiring a tougher consistency by extraction of water. The latter is widened during the flow of the *Amœba* at the posterior end by all sorts of processes, lobes, hairs, &c., which often give the *Amœba* a peculiar aspect and have led to the establishment of distinct species. The sarcode here becomes so tough that as the *Amœba* hastens forward it is drawn into threads, if the expression may be allowed.

"If the direction of movement is reversed the previous posterior extremity begins to flow, and the most tenacious protoplasm occurs on the opposite side. These conditions may be equally well studied on the lobate pseudopodia, as also during the retraction of the pseudopodium on the surface of which all sorts of humps and folds are produced.

"A tougher cortical zone of this kind is actually to be seen in the forms here under consideration. When there is a centripetal pressure acting uniformly it surrounds the whole *Amœba* like a membrane; if the pressure ceases on all sides the *Amœba* flattens into a disk, the cortical zone liquefies and flows into a clear border of more fluid sarcode, but if the pressure acts on one side the liquefaction takes place only on the opposite side, and the mode of movement which may be called the flow of the *Amœba* is produced.

"In the formation of individual pseudopodia (see *A. tentaculata*) it is only a few spots that are subjected to these conditions, and in accordance with this the tougher cortex dissolves only at certain points, making way for the issuing softer sarcode."

Protozoa of the White Sea.*— C. Gobi gives a sketch of Professor Cienkowski's report on his expedition to the White Sea, which appears in the 'Proceedings of the Natural History Society of St. Petersburg' in the Russian tongue, and is illustrated with three coloured plates.

The sea was by no means rich in microscopical organisms, but still a few new and interesting forms were found, and are described and figured, such as *Wagneria mereschkowskii*, a new genus and species of *Protista*, somewhat between *Haeckelina* and *Clathrulina*; several new Flagellata, *Multicilia marina* nov. gen. et sp., having a protoplasmic body of protean form without nucleus or contractile vesicle, but having several cilia; *Exuviaella marina*, also new, with an ovum-like body, flattened horizontally at the top, with two cilia and one or two round marks (*Schildchen*); *Daphnidium boreale* nov.

* Cf. 'Nature,' xxv. (1882) p. 328.

gen. et sp., with a spherical body, prolonged into a curved beak, giving origin to one long cilium. In the dead cells of *Pylaicella* and other Phæosporous Algæ there was found a colourless form of a *Labyrinthula* which had previously been found thriving in the cells of a *Lemna.* Finally, a new Moner, *Gobiella borealis,* which shows a great resemblance to *Vampyrella,* but the green contents seem never to extend into the pseudopodia.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Free Cell-formation in the Embryo-sac of Angiosperms.*—Dr. F. Soltwedel thus sums up the results of a series of observations on this subject on various plants:—

The mode in which the mature nucleus is developed from the homogeneous lump of nuclear substance may be regarded as a formation of vacuoles within it. The contents of the vacuoles constitute the nuclear sap, the nucleoli and the nuclear network and external layer proceeding from the substance of the nucleus. Since in many mature nuclei no external substance is to be recognized, and the nuclear sap is in these cases always sharply differentiated from the surrounding protoplasm, it may be assumed that the nucleus is surrounded by a nuclear membrane, which may be formed by a chemical action either of the nuclear substance or sap upon the surrounding protoplasm.

When the nucleus multiplies, the nuclear substance alone divides, and forms first of all the primary spindle. At this stage the nuclear sap penetrates into the surrounding protoplasm, the nuclear membrane being always absorbed or ruptured. The protoplasm, which now advances to the rods of the primary spindle, surrounds them with a denser layer, and forms in this way the spindle-fibres. These are visible at the poles when the nuclear substance is pressed to the equator. After the halves of the nuclear plates separate, the spindle-fibres remain between them as empty sacs.

Coalescence of the nuclei is effected by the disappearance of the nuclear membranes at the point of contact of the nuclei, and the union of the corresponding constituents. Before the nuclei break up they attain a very considerable size; their membranes are finally absorbed, the nuclear sap mingles with the surrounding protoplasm, and the nuclear substance breaks up, with the formation of vacuoles in the interior, into small pieces, which afterwards deliquesce in the protoplasm. The nuclear membranes are made up of small granules, the composition of which could not be detected.

Structure and Division of the Vegetable Cell.†—In a paper on this subject Mr. J. M. Macfarlane, Demonstrator of Botany in the University of Edinburgh, says that on examining the epidermal

* Jenaische Zeitschr. f. Naturwiss., xv. (1881) pp. 341–80 (3 pls.).
† Trans. Bot. Soc. Edinb., xiv. (1881) pp. 192–219 (2 pls.).

cells of *Ornithogalum pyramidale* he found what seemed a well-marked body inside the nucleolus of a cell, and the same was found on carefully examining the others. The epidermis was quite fresh, and had been stained in alcoholic solution of eosin—an excellent stain for demonstrating minute structure. Numerous other flowering plants were examined, and in the whole of these the new structure was found to be present in the cells of the epidermis, lamina, petiole, stem, and root, as also in Cryptogams, such as *Equisetum limosum*, *Chara*, *Spirogyra*, &c. It is round or slightly oval in outline, and exhibits a clear bounding wall, differentiating it from the substance of the nucleolus. Aqueous solution of logwood reveals the outline well, still better is a solution of iodine; but preferable to either of these is a $\frac{1}{4}$ per cent. solution of eosin in common methylated spirit.*

To this new factor in the vegetable cell the author proposes to apply the term *nucleolo-nucleus.* His investigations led him strongly to the conclusion that the nucleolus is also an invariable element; in fact, all the tissue systems of every plant which have come under his notice in the present connection have been found to be provided invariably with a nucleus, nucleolus, and nucleolo-nucleus, *if the cell is still active.* To ascertain, if possible, the function of these, and their *rôle* in division of the cell, he examined *Ornithogalum pyramidale*, *Scilla bifolia*, *Spirogyra nitida*, and *Equisetum limosum*, and the general results as to division are summed up thus:—

(*a*) In division of the cell the nucleolo-nucleus probably divides first.

(*b*) The nucleolus undoubtedly divides next, and this is followed by division of the nucleus.

(*c*) During division of the nucleus a nuclear plate with nuclear disk is formed occasionally.

(*d*) If a septum is laid down, this is always preceded by formation of a nuclear barrel and cell-plate.

Fertilization of Apocynaceæ.†—F. Ludwig gives a comparative sketch of the various very interesting modes of cross-fertilization in the Apocynaceæ, especially in the genera *Apocynum*, *Vinca*, and *Nerium*, illustrated with woodcuts.

Cross-fertilization and Distribution of Seeds.‡—F. Hildebrand describes the peculiar arrangements for cross-fertilization in *Eremurus spectabilis* (Liliaceæ), in which the perianth withers before either the male or female organ is mature; and in *Rhodora canadensis*, in which self-fertilization is almost absolutely prevented by the position of the stigma.

In *Aponogeton distachyum* the distribution of the seeds is promoted by their possessing air-containing intercellular spaces, by means

* The author also says that he examined a preparation of cerebellum. "In the large multipolar nerve-cells a nucleolus has long been known to exist, but inside many nucleoli this new structure was quite visible. . . . . It has been mentioned before casually, but no importance was attached to it. On looking over various zoological works one finds that it is figured repeatedly."

† Bot. Centralbl., viii. (1881) pp. 183–9.

‡ 'Flora,' lxiv. (1881) pp. 497–504 (1 pl.).

of which they float on the water—an arrangement similar to that found in the white and yellow water-lilies.

Swelling of the Pea.*—F. Schindler has investigated the phenomena of the swelling of the seeds of Papilionaceæ in the case of ten varieties of *Pisum sativum.* He finds all the three stages indicated by Nobbe well displayed in all cases; but each variety was characterized by special peculiarities. The power of swelling was found in general to be in proportion to the specific gravity of the seed. The following may be stated as the general results of the investigation:—

The first penetration of water into the testa of the pea usually takes place through the micropyle, which, with few exceptions, provides an open communication with the external air. Advantage is next taken of the longitudinal fissure of the hilum. The anatomical structure of the layer of stellate parenchyma presents great facilities for swelling; and this absorbs a large proportion of the water admitted through the micropyle, the quantity being sufficient for the first development of the embryo. The spiral vessels of the testa serve as capillary tubes for the conduction of water.

Aril of Ravenala.†—According to Dr. F. R. v. Höhnel, the aril of the seeds of the "traveller's tree," *Ravenala madagascariensis*, is, when fresh, of a beautiful azure-blue colour, and is the only known example of an aril from which an oil is obtained for economical purposes.‡ The author believes that in this instance the bright colour prevents the seed being eaten by birds. The aril is entirely cellular in its structure, the cells being elongated, thin-walled, and with very small intercellular spaces. They are filled with a homogeneous, finely granular, blue mass, consisting of protoplasm and an oil which contains the blue pigment in solution. This substance appears to be peculiar to the species, and of unknown composition.

Structure and Mechanics of Stomata.§—S. Schwendener describes in detail the points of anatomical structure connected with the opening and closing of stomata.

Of the contrivances on which the motility of the guard-cells depends, the most important is that which the author describes as the "epidermal hinge" (*Hautgelenk*), which is placed right and left of the guard-cells in the outer wall of the adjoining epidermal cells. It consists of a thin spot in this wall, never wanting in plants with a thick-walled epidermis, though frequently absent from those where it would be superfluous, viz. where the outer wall of the epidermis is thin. In those cases where the stomata are depressed, they are surrounded by delicate lamellæ of cellulose, which constitute the hinge, attached either to the margins of the fissure, or to the round opening which perforates the outer wall of the epidermis.

The wall which separates the guard-cell from the adjoining

* Wollny's Forsch. aus Geb. der Agriculturphysik, iv. (1881) p. 190. See Bot. Centralbl., vii. (1881) p. 360.

† Oesterr. Bot. Zeitschr., xxxi. (1881) pp. 386–7.

‡ The aril of the nutmeg (mace) yields a well-known oil.—Ed.

§ MB. K. Akad. Wiss. Berlin, 1881, pp. 837–67 (1 pl.).

epidermal cell, if not thin and easily permeable, as is the case where the guard-cells are weak in mechanical structure, has invariably a thin spot which is readily permeable. Where the wall of the guard-cell is otherwise entirely cuticularized, this spot consists of ordinary cellulose. The opposite ventral wall of the guard-cell, bounding the fissure itself, also has always a thin spot. When the cuticle covers the ventral wall of the guard-cells up to the fissure, it is not interrupted at the thin spot. These thin strips constitute a hinge.

Elsewhere the walls of the guard-cells are thickened in a great variety of ways; the outer and inner parts of the ventral surface usually prismatically. By these prismatic thickenings, when the guard-cells become more turgid, a strong elongation of the thin-walled dorsal side is brought about, by which the guard-cells are made to curve, because the thickenings of the ventral wall give them increased power to withstand traction. No curvature of the guard-cells can take place here in consequence of any greater increase in length of the dorsal wall. The motility of such guard-cells appears therefore to be less when mature than when young, when the form of the cells more nearly resembles those with prismatic thickenings. In many plants it is only the thickening ridges which face the interior of the leaf that are capable of curving. The thickenings gradually disappear at their ends, and do not usually coalesce. The guard-cells are often considerably higher at the two ends than at the middle. In many thick phyllodes and evergreen leaves the very narrow cell-walls are bounded above and below by strong thickening stripes, often furnished with prominent cuticular ridges.

Those stomata of which the guard-cells have no cell-cavities are often comparatively immotile, in extreme cases, perhaps, absolutely so.

The mode of motion may be made out by comparing the open and closed conditions of the stomata. For this purpose both vertical and transverse sections should be made; and care must be taken to allow for the increase of turgidity caused by glycerin. The general results of a careful series of measurements is that the size of the guard-cells is greater when the fissure is open than when it is closed.

The movements are caused by increase and decrease of the hydrostatic pressure in the guard-cells. When the turgidity is increasing, the increase of the thin dorsal wall of the guard-cell amounts to about 9 per cent., and the increase in volume of the entire guard-cell to about 17 per cent. The hydrostatic pressure necessary to produce this effect on a cell-wall 1 or 2 μ thick, is respectively that of 5 or 10 atmospheres. It is only when the pressure in the guard-cells exceeds that of the adjoining epidermal cells that the stoma can open. This is effected by a curvature of the guard-cells, caused by the difference in structure of the dorsal and ventral walls, as can be shown experimentally by a caoutchouc-tube.

When there is no tension the stomata are open only in some water plants. In some Monocotyledons (as *Tradescantia discolor*) there is a difference from the normal structure as regards the changes in form, the peculiar structure causing an expansion of the guard-cells in a direction vertical to the surface of the leaf, which increases and

decreases with the degree of turgidity. When there is no tension the ventral wall projects; and the thin spot then acts as the hinge between the thickenings.

The result of the movement is (in *Helleborus*) that the anterior chamber of the stoma remains unchanged, while the posterior chamber is greatly narrowed by the closing; the ventral walls of the guard-cells turning on their outer lines of attachment, and bending considerably. The mechanical nature of this process may be determined by observing the change in form of the cell-cavity. When there is no tension, the transverse section of the cavity represents a scalene triangle, pressure tending to change it to an equilateral form, which causes the movement. That this must be the case the author has proved by an experimental apparatus constructed for the purpose.

As regards the purpose of each separate part of the stoma, the two thickening-ridges may be compared to a half-open portfolio; the delicate lamella of cell-wall which unites them to the hinge or back. The uniform strength of the thickening-ridges from one end to the other of the fissure is a contrivance to assist the curvature. When the posterior chamber of the stoma is enlarged by the increased turgidity of the guard-cells, the breadth of the hinge increases, as is essential. Turgidity then causes, firstly, a curvature of the cells, and in the second place an enlargement of the posterior chamber. With increase of age the thickenings become stronger, the opening of the stoma being thus rendered more difficult, and, finally, impossible. In many cases they are ultimately closed by thyllose structures.

The turgidity of the guard-cells is dependent on the influence of light. The fissure was always open (in *Amaryllis formosissima*) after the plant had been exposed for from one to two hours to direct sunlight; while the stomata were always closed when the plant had remained for some time in the dark. Within ordinary variations of temperature heat alone does not cause the fissure to open.

Callus-plates of Sieve-tubes.*—E. Russow has successfully employed aniline blue for colouring the callus-plates of sieve-tubes. An aqueous solution of this pigment is taken up in larger quantities and more firmly held by these plates than by the other parts of the sieve-tubes, out of which it can be washed by water. The same effect was not produced by other aniline dyes, as aniline brown. The fine structure was best exhibited by treating it with chloriodide of zinc containing an excess of potassium iodide either before or after colouring with the aniline blue.

Out of a large number of species examined, Russow found callus-plates in *Alsophila australis*, *Balantium antarcticum*, *Osmunda regalis*, *Equisetum arvense* (but not in *Pteris aquilina*, *Marsilea*, or *Lycopodium*); and in all families of Gymnosperms, Monocotyledons, and Dicotyledons.

In *Abies Pichta* large callus-cushions were found, composed of radially arranged parts with a crystalline appearance, which were evidently doubly refractive. The callus-layers of the sieve-plates of

* SB. Dorpater Naturf.-Ges., 1881, April 23. See Bot. Ztg., xxxix. (1881) p. 723.

Abies excelsa and *Larix sibirica* were partially dissolved by water or glycerin, the parts of the cortex containing them being taken from the stem in April. The sieve-plates of *Equisetum* are perforated by "combining-bundles," which have not been found in true ferns.

The author states that the callus-layers are usually to be found only in the younger or even the youngest parts of the cortex while still in a state of vital activity, and considers it probable that the specific function of sieve-tubes commences with the formation of callus, and lasts only so long as this structure endures.

Phyllomic Nectar Glands in Poplars.*—W. Trelease calls attention to the fact that these glands have been very generally overlooked, and that they have been considered of little value by the systematic botanist. He accounts for this by their being occasionally suppressed, and by their limitation to the earlier-formed leaves. Still, most of the American botanists refer to them, and Michaux figures them in his monograph of the genus. In May 1880, Mr. Trelease's attention was drawn by the action of some bees to examine the leaves of a small aspen. The tree was covered with its newly expanded foliage, and the bees were flying from leaf to leaf; they were seen to be collecting nectar, which was poured out from a double gland at the base of each leaf. These glands were placed on the upper surface of the petiole at its union with the blade. On section and microscopical examination, they showed the usual structure. They were found not to occur on all leaves, but as a rule only on the first half-dozen or less which appear on each branch in the early spring; and later on in the season, when these have fallen off, one may sometimes examine all the leaves without detecting a single glanduliferous one, and this on a species which produced them in abundance earlier in the year. From an examination of the American species it would seem that the greater number possess two or more distinct or confluent glands, situated where the blade and petiole join; and in those few species where none were discovered it is quite possible that a closer examination in the spring-time may show that they exist. Thus on *P. tremula*, the weeping variety, a careful examination in early May failed to show a single gland; but a week or two later, after several days' rain, the young branches grew very rapidly for a short time, unfolding many new leaves, and the first three or four of these on each branch bore large and active glands. The nectar is greedily gathered by insects, chiefly Hymenoptera and Diptera. The most numerous were the ants, who, as is usual in such cases, would fight rather than give up a good position near a nectar-secreting gland. The author regards these glands as protective.

Histology of Urticaceæ.†—Karl von Demeter publishes (in Magyar), an exhaustive account of the histology of Urticaceæ, especially in relation to *Boehmeria biloba*, though reference is made also to many other species.

* Bot. Gazette, 1881. Cf. 'Nature,' xxv. (1882) pp. 327–8.

† K. von Demeter: 'Histology of Urticaceæ, with special reference to *Boehmeria biloba*' (in Magyar), Klausenburg, 1881, 43 pp., 2 pls.

Structure of Podostemonaceæ.*—Prof. E. Warming has carefully studied the anatomy and morphology of this order of flowering plants: especially in the cases of *Podostemon Ceratophyllum* and *Mniopsis Weddelliana* and *Glazioviana.* The following are his chief points :—

Stomata are altogether wanting. The epidermal cells are more or less polygonal; the cuticle is weak. The fundamental tissue consists mainly of parenchymatous cells, usually somewhat elongated longitudinally, especially the nearer they are to the fibrovascular bundles. Their walls are often somewhat collenchymatous, swelling easily in caustic alkali, by which a central lamella is distinctly visible. Intercellular spaces are either entirely wanting or extremely inconsiderable. All the cell-walls consist of pure cellulose, with the exception of the tracheides of the xylem which are slightly lignified. Large quantities of starch are often present in the fundamental tissue. The cell-walls have a strong tendency to excrete silica, which frequently entirely fills up the cell-cavities. This takes place in all the organs, but especially in the epidermis.

The roots are plagiotropous and distinctly dorsiventral, and are hence often flat; they contain sieve-tubes, and nearly always have a root-cap, which is often oblique. They have a great power of regeneration when detached. They attach themselves by means of root-hairs, and of peculiar organs which he terms *haptera*, consisting of protuberances which spring from the under side of the roots.

Each fibrovascular bundle may be traced up into a leaf; every leaf receiving one bundle. They consist, in the stem, of soft bast (sieve-tubes and cambiform) with a few spiral and annular vessels, and are supported by a collenchyma which is especially developed on the dorsal side; its cells have a strong resemblance to true bast-cells. The epidermis of the leaves is not strongly developed; it contains chlorophyll, and some of its cells are prolonged into short hairs. The mesophyll resembles the fundamental tissue of the stem; there is no palisade-tissue. The vascular bundles of the veins are but feebly developed; sieve-tubes were not observed; but, on the other hand, sheaths, composed of true bast-fibres.

Pitchers of Cephalotus follicularis.†—In continuation of his previous researches on the morphology of the pitchers of pitcher-bearing plants, A. W. Eichler traces the development of those of *Cephalotus follicularis* and *Nepenthes phyllamphora.* In the former plant the pitcher is certainly the modified lamina; in the latter possibly, as Hooker believes, an appendicular formation; in a certain sense an excessively developed gland, separated by means of a stalk from the flat basal part which represents the true lamina. Certainly the lid of the pitcher of *Nepenthes* is not the true blade, as many suppose.

Action of Light on Vegetation.‡—Professor N. Pringsheim thus sums up the results derived from his previously recorded observations.

* Vidensk. Selsk. Skr. Räkke, VI. ii. (1881) 6 pl. (French abstract). See Bot. Centralbl., viii. (1881) p. 108.

† JB. K. Bot. Gart. Berlin, i. (1881) pp. 193–7.

‡ MB. K. Akad. Wiss. Berlin, 1881, pp. 504–35.

The primary action of the rays of the sun on vegetation consists in thermic and photo-chemical effects, the influence of which on the separate constituents of the cells is directly recognizable in intense light. The photo-chemical effects relate exclusively to the behaviour of the plant towards the oxygen and carbonic acid of the atmosphere; they are simply changes of intensity in the interchange of gases. These have been fully determined in the absorption of oxygen, less completely in that of carbonic acid. It cannot be then that light produces any other effect on the plant than the thermic and the photo-chemical.

All the action of light on the phenomena of vegetable life, not merely on growth and metastasis, but also the so-called mechanical and vital movements of irritation caused by light, can readily be traced to purely thermic and photo-chemical effects. A more exact knowledge of them requires, however, a special investigation of the behaviour of those constituents of the cell which are sensitive to light, i. e. which are photo-chemically excitable. For an investigation of them, and of their differences from those constituents which are not excitable photo-chemically, the reader is referred to the author's treatises on the functions of chlorophyll and the action of light upon it.*

Production of Heat by Intramolecular Respiration.†—Dr. J. Eriksson has made a series of observations for the purpose of determining the amount of heat, and the length of time for which it lasts, caused by the intramolecular respiration of plants. The experiments were made with the inflorescence of Aroideæ, the flowers of other plants, ripe fruits, germinating seeds, and yeast-cells, care being taken to exclude the access of atmospheric oxygen. In most cases the elevation of temperature under these circumstances did not exceed 0·2° C., while access of air caused a rise of about 1°. With seedlings of lentil the elevation of temperature continued for six days; with buckwheat for two days. In the case of fermenting yeast, however, an elevation of 3·9° was observed, which was not increased by the subsequent letting in of a stream of air. Yeast not in a state of fermentation showed only the slight rise of temperature common to other plants.

Physiological Functions of Transpiration.‡—F. Reinitzer propounds the theory that transpiration is an injurious agent, a necessary evil, in the life of the plant. This view he founds on the fact that transpiration exercises a retarding influence on growth. He regards woody tissue as the cause of rapid movements of water in the plant, rather than as being—according to Sachs's view—formed as the result of such movements.

Metastasis.§—The first volume of Pfeffer's 'Handbook of Metastasis and Metacrasis' (*Stoffwechsel u. Kraftwechsel*) is occupied

* See this Journal, iii. (1880) pp. 117, 480; i. (1881) p. 479.

† Unters. aus dem bot. Inst. Tübingen, i. (1881). See Bot. Ztg., xxxix. (1881) p. 597.

‡ SB. Akad. Wiss. Wien, lxxxiii. (1881) pp. 11–36.

§ W. Pfeffer, 'Stoffwechsel,' 383 pp. (39 figs.). Leipzig, 1881.

with the former of these subjects, and is divided under the following heads:—

The physical properties and molecular structure of organized bodies; including the form of the micella, the mechanical phenomena of swelling, the change of physical properties occasioned by it, and the structure of protoplasm. The mechanical phenomena of metastasis, including the osmotic properties of cells, cuticle, and cork, the osmotic pressure in cells, the power of selection, the specific osmotic capacity of the various organs, and the properties and influence of the soil. The mechanical phenomena of the interchange of gases, including the passage of gases through the cells and cell-walls, stomata and lenticels as conductors of gases, the pressure of gases, &c. The movements of water, including transpiration and the excretion of water. Food-materials, including the production of organic substances and decomposition of carbonic acid gas, the absorption of organic food, the synthesis of nitrogenous substance, and the composition of the ash. The movements of fluid and solid substances, as gums, resins, pigments, and other nitrogenous and non-nitrogenous substances, the constituents of the ash, &c., and the movements which take place during germination. Respiration and fermentation, including the products of respiration, the relation between normal and intramolecular respiration, and the influence of external conditions.

Phosphorescence in Plants.*—L. Crié calls attention to some new cases of phosphorescence in plants. As is known, the flowers of Phanerogams will, under certain circumstances, show phosphorescent gleams, and a few years ago, in stormy weather, the author saw phosphorescence produced by the flowers of *Tropæolum majus*. This emission of light is characteristic of Fungi, especially *Agaricus olearius*, *A. igneus*, *A. noctilucens*, *A. Gardneri*, *A. lampas*, and several other Australian forms, also *Auricularia phosphorea* and *Polyporus citrinus*. The luminous strings of *Rhizomorpha subterranea* are readily observable in the Pontpéan mine, near Rennes. M. Crié also cites *Rhizomorpha setiformis* and a particular form of *Rhizomorpha* which he has observed in the interior of branches of the elder. Having divided a number of these branches in the interior of which filaments of a *Rhizomorpha* were developed, between the wood and the pith, the author was surprised to see very faint gleams produced by the fungus. It possesses a reproductive apparatus which seems by its organization identical with the conidiophorous clavicle of *Stilbum*. Only those filaments that bore abundance of conidia produced phosphorescent gleams. Finally, *Xylaria polymorpha*, gathered on old stumps in a garden, emitted faint white gleams comparable to those produced by phosphorus when oxydizing. In both cases the author considers the phosphorescence to be an effect of the respiration of the conidiophorous portions of *Rhizomorpha* and *Xylaria*.

Transformation of Starch.†—W. Detmer states that the presence of carbonic acid greatly promotes the transformation of starch into

* Comptes Rendus, xciii. (1881) pp. 853–4.
† SB. Jenaisch. Ges. für Med. u. Naturw., 1881, June 17.

diastase in the vegetable cell; and the same effect is produced by small quantities of organic acids as citric acid. The degree of acidity of any particular part of a plant is constantly changing. He believes also that the chief cause of the turgidity of the cell is the presence of vegetable acids, which have the special quality of inducing endosmose, and the presence of which greatly promotes the growth of the plant.

Occurrence of Allantoin in the Vegetable Organism.*—If branches of woody plants covered with buds are cut off and placed in water until the buds unfold, the young shoots and leaves are found to be rich in asparagin, formed most probably by decomposition of albuminoids. E. Schultze and J. Barbieri have undertaken a number of experiments for the purpose of determining whether in these cases, in addition to the amide, other nitrogenous substances are found. By a similar treatment they obtained, besides asparagin, a highly nitrogenous body, which appears to be identical with allantoin both in its composition and in its reactions. This derivative of uric acid was found in no inconsiderable quantity, amounting to from 0·5 to 1·0 per cent. of the air-dried substance.

Excretion of Water on the Surface of Nectaries.†—Dr. W. P. Wilson attributes this phenomenon to osmose, and not to any internal pressure; a view which he supports by the fact that washing the nectaries with water and then drying them with blotting-paper stops the excretion. With regard to the influence of light on the excretion, with some plants no effect was observed, while with others it was greatly increased by direct sunlight.

Determination of the Activity of Assimilation by the Bubbles given off under water.‡—Sachs proposed the method of determining the intensity of the assimilation of water-plants by counting the number of bubbles of gas given off in a certain time. To this plan the objection was made that the bubbles might be the result of some other cause than assimilation. Dr. F. Schwarz has now confirmed the accuracy of Sachs's method, by determining that the presence of carbonic acid in the surrounding water is an indispensable condition to the giving off of the strings of bubbles.

Detmer's Vegetable Physiology.§—The 7th section of Schenk's 'Handbook of Botany' is occupied by a treatise on Physiology by Detmer. The following are the subjects comprised in it:—Food-materials of Plants, including the Process of Assimilation; Origin of the Proteinaceous Substances; Composition of the Ash of Plants; Organic Compounds as Food-materials; the Molecular Forces in Plants; the Movements of Gases; the Absorption of Water; the Movements of Fluids; the Absorption of Mineral Substances; and the Process of Metastasis.

* Berichte der deutsch. chemisch. Gesellsch., xiv. p. 1602. See 'Naturforscher,' xiv. (1881) p. 481.

† Unters. aus dem bot. Inst. Tübingen, i. (1881). See Bot. Ztg., xxxix. (1881) p. 545.

‡ Unters. aus dem bot. Inst. Tübingen, i. (1881).

§ W. Detmer, System d. Pflanzenphysiologie, 1881.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Development of Sporangia.*—K. Goebel continues his researches into the comparative history of development of the sporangia of the higher cryptogams.† These are all characterized by the presence of an "archespore."

The Marattiaceæ were examined chiefly in the example of *Angiopteris evecta*. The sporangia are developed from a group of superficial cells, on the receptacle formed by the superficial cells of the depression of the sorus, corresponding to the placenta of phanerogams. Here also it is the hypodermal terminal cell of the axial row of cells of the rudiment of the sporangium that gives rise to the whole of the sporogenous tissue. By the formation of anticlinal and periclinal walls in the cell above the archespore, it becomes subsequently imbedded in the interior of the tissue. The *Tapetenzellen* arise from the cells which bound the archespore. *Marattia cicutæfolia* and *alata* agree in all essential points.

In *Ophioglossum* it is probable that the sporogenous tissue also proceeds from either a hypodermal or a superficial cell. Cells are produced by periclinal divisions of the parietal cells, which very soon become compressed, and which may also by analogy be termed *Tapetenzellen*. The processes are very similar in *Botrychium* and *Anemia*.

The investigations on *Equisetum* do not confirm Milde's view that the sporangia are produced on the surface of leaves. The apical cell of the sporangial fructification becomes, on the contrary, soon enclosed in a small-celled tissue.

The author enters with considerable detail into the development of the sporangia of the Psiloteæ, especially *Psilotum* and *Tmesipteris*. He agrees on the whole with the view of Sachs and Strasburger that the sporangia are here not the product of the leaves, but are more or less imbedded in the tissue of short lateral axes. The Psiloteæ are, therefore, widely separated from the Lycopodiaceæ by this difference in structure.

In *Selaginella* the sporangia arise from superficial cells of the vegetative apex of the stem, which lie immediately above those from which the apex of the leaf proceeds. The archespore is again the hypodermal terminal cell of the axial row. The radially elongated cells which clothe the inner surface of mature sporangia may be regarded as *Tapetenzellen*. The outermost of them are given off by the archespore; while those near the pedicel are separated from the adjacent cells.

The morphological value of the sporangia of the Archegoniatæ, therefore, varies greatly.

The author then compares the development of the sporangia of the higher cryptogams with that of the pollen-sacs or microsporangia of

* Bot. Ztg., xxxix. (1881) pp. 681–94; 697–706; 713–20 (1 pl.).

† See this Journal, iii. (1880) p. 987.

conifers, and finds a very close correspondence between them. The prolongation of the staminal shield which, in most Cupressineæ, protects the pollen-sacs when young, he regards, from analogy with ferns, as an indusium.

To the view previously expressed that the divisions in the embryo-sac of phanerogams are nothing but divisions of the archespore, he adds two illustrative examples, in *Callitris quadrivalvis* and *Cupressus sempervirens*, in which the reduction in the divisions of the embryo-sac does not go so far as usual.

The author concludes with the following classification of vascular cryptogams and phanerogams.

I. Leptosporangiatæ.
  A. Filices.
    (1) Homosporæ (Polypodiaceæ, Gleicheniaceæ, Cyatheaceæ, &c.).
    (2) Heterosporæ (Salviniaceæ).
  B. Marsiliaceæ (Marsilia, Pilularia).
II. Eusporangiatæ.
  A. Filicales.
    (1) Marattiaceæ.
    (2) Ophioglossaceæ.
  B. Equisetineæ.
    (1) Calamites.
    (2) Equisetaceæ.
  C. Sphenophyllaceæ (the formation of the sporangia resembles that of the heterosporous Lycopodineæ, that of the leaves corresponds to Equisetum).
  D. Lycopodineæ.
    (1) Lycopodiaceæ.
      a. Homosporæ (Lycopodium).
      b. Heterosporæ (Lepidodendron, Sigillarieæ ?).
    (2) Psilotaceæ.
    (3) Selaginellaceæ.
    (4) Isoeteæ.
  E. Gymnospermæ.
  F. Angiospermæ.

Lenticels of the Marattiaceæ.*—H. Potonié has examined the structure of the lenticels in the leaf-stalk of *Angiopteris crassipes*, *evecta*, *Teysmanniana* and *Willinkii*, and *Marattia fraxinea;* and describes those of *A. evecta* in detail. In all the Marattiaceæ the stomata are arranged in rows, in the centre of which lenticels are very commonly found. Their production begins by the walls of one or more stomata, and of the epidermal cells which surround them, becoming brown and dry; the subjacent parenchyma then developing into phellogen by repeated periclinal divisions, and the outermost of the cell-layers also becoming brown and dry. The cell-walls cuticularize, and small interstices appear between the dry cells; the space occupied

* JB. K. Bot. Gart. Berlin, i. (1881) pp. 307–10. See Bot. Centralbl., viii. (1881) p. 70.

by the entire tissue decreases, and the lenticels appear somewhat depressed. This firm dry mass of tissue constitutes, therefore, a protection to that which lies beneath, and its physiological function is the same as that of the lenticels in flowering plants.

Stomata in the Leaf-stalk of Filicineæ.*—H. Potonié states that the arrangement of the stomata in the leaf-stalk of Filicineæ has a direct relation to the anatomical structure of the stem and to the development of the mechanical tissue. The latter is always peripheral, and forms the cylinder of stereome or sclerenchyma; but it may either be hypodermal, or separated from the epidermis by a parenchymatous assimilating tissue. In the former case the stomata are arranged in two rows on the two sides of the leaf-stalk; in the latter case they are distributed over its surface. The former arrangement occurs in *Adiantum*, *Anemia*, *Cyathea*, *Cystopteris*, *Davallia*, *Dicksonia*, *Gymnogramme*, *Lomaria*, *Lygodium*, *Nephrodium*, *Nephrolepis*, *Onoclea*, *Pellæa*, *Polypodium*, and *Pteris;* also in *Hymenophyllum* and *Trichomanes*, as far as relates to the structure of the stem. The second form occurs in *Alsophila*, *Asplenium*, Marattiaceæ, *Marsilia*, and *Todea*, although in the last the parenchyma subsequently passes into stereome.

The author gives the following classification of Filicineæ in reference to this point of structure:—1. Without stomata in the leaf-stalks: Hymenophyllaceæ [Salviniaceæ]. 2. Stomata arranged in two rows: Polypodiaceæ, Cyatheaceæ, Schizæaceæ [Gleicheniaceæ]. 3. Stomata distributed over the surface of the leaf-stalk: Osmundaceæ, Marattiaceæ, Ophioglossaceæ, Marsiliaceæ.

Adventitious Buds on the Lamina of the Frond of Asplenium bulbiferum.†—E. Heinricher has pursued his investigations on this subject, especially as regards the youngest stages, for the purpose of confirming his previous statement ‡ that these buds may originate from a single superficial cell, in which triangularly segmented apical cells were formed. The general result obtained may be stated as follows:—These adventitious buds proceed from a single superficial cell, which proceeds immediately to the formation of a three-sided apical cell. This apical cell is usually the result of three divisions; but cases are depicted in which it results from two and from four divisions respectively. The conclusion of the author is, therefore, at variance with that of A. Zimmermann, that several epidermal cells may take part in their formation.

Anatomy and Classification of Schizæaceæ.§—K. Prantl publishes a preliminary treatise, occupied chiefly with the classification of this tribe of ferns. The following are the genera and subgenera which he adopts:—(1) *Lygodium* (*Palmata*, *Flexuosa*, *Volubilia*); (2) *Mohria*; (3) *Aneimia* (*Trochopteris*, *Hemianeimia*, *Euaneimia*, *Aneimiorrhiza*); (4) *Schizæa*.

* JB. K. Bot. Gart. Berlin, i. (1881) pp. 310–17. See Bot. Centralbl., viii. (1881) p 70.
† SB. K. Akad. Wiss. Wien, lxxxiv. (1881) p. 115–20 (1 pl.).
‡ See this Journal, ii. (1879) p. 597.
§ Engler's Bot. Jahrb., ii. (1881) p. 297.

Biological peculiarity of Azolla caroliniana.*—M. Westermaier and H. Ambronn have observed that this species presents the peculiarity of throwing off the root-cap from older roots, a great number of hairs being also formed at the apex. An organ is thus produced which resembles the submerged leaf of *Salvinia* in both form and function. A structure which is neither normal leaf nor normal root is formed, in *Azolla* by the metamorphosis of a true root, in *Salvinia* by the abnormal development of an organ which originates as a normal leaf. These root-hairs of *Azolla caroliniana* are produced in moderately regular transverse rows, each proceeding from a segment of the triangular-pyramidal apical cell. This tendency reaches at length the apical cell and youngest segments, and causes the root-cap to be thrown off.

Muscineæ.

Female Receptacle of the Jungermannieæ Geocalyceæ.†—Leitgeb has established the general rule that the female receptacle of the Jungermannieæ always originates in the apex of the shoot, and that wherever archegonia are found on older parts of the stem, they are always products of a lateral shoot. This rule applies to all Hepaticæ; there is only this point of difference, whether or not the apical cell is completely absorbed in the formation of the archegonia. In the former case the receptacle then actually occupies the apex of the axis, which it does not appear to do in the latter case. These two modes of life of the Hepaticæ he terms *acrogynous* and *anacrogynous*. No exception was found to this rule in a very large number of species examined. In all cases the origin of the archegonia at spots distant from the apex of the stem can be traced back to an intercalary lateral shoot. To this case belong the archegonia which spring from the ventral side of the stem in *Calypogeia*, *Geocalyx*, and *Sarcogyne*. But in the family of Geocalyceæ there are some genera in which the archegonial receptacles have not a ventral insertion, but either stand at the apex of a shoot, or the mouth of the fertile tube lies on the dorsal side of the stem.

The most remarkable peculiarities are presented by *Gongylanthus ericetorum*, from Madeira, where all the archegonial receptacles are seated in a fork of the stem, forming also the close of an axis, the apical cell of which is used up in this formation. In contrast to the rest of the European Geocalyceæ, the archegonial receptacles are in this species produced at the apex of normally leafy aerial shoots. They are always preceded by the production of lateral branches, the rapid and early development of which causes their insertion to coalesce completely with the imbedded receptacle, which projects as a protuberance on the ventral side. The consequence of this is that the receptacle is completely pressed aside from the margin of the fork to the dorsal side of the shoot. This displacement must not be regarded as a phenomenon which takes place only on the reproductive shoots; it is a necessary result of the earlier development of the lateral shoot,

* Abhandl. Bot. Ver. Prov. Brandenburg, xxii. (1880) pp. 58–61 (1 pl.). See Bot. Ztg., xxxix. (1881) p. 580.

† SB. K. Akad. Wiss. Wien, lxxxiii. (1881).

and of the hyponasty which belongs also to the apex of the sterile shoots, and which does not afterwards disappear, but becomes fixed in consequence of the origin of the female receptacle, and of the arrest of growth in length. The genus, therefore, presents no difference from the rest of the acrogynous Jungermannieæ in the position of the female receptacle.

In *Podanthe*, *Lophocolea*, and *Gymnanthe* the receptacle, and hence the fertile tube, are terminal. The normal production of lateral shoots ceases in these genera before the formation of the female receptacle. *Lindigina* presents as a rule the same peculiarities as *Gongylanthus*; while *Marsupidium* more closely resembles in this respect *Calypogeia* and its allies. The reproductive shoots originate in an intercalary manner on the ventral side.

Vegetative Reproduction of Sphagnum.*—C. Warnstorf has observed that when tufts of *Sphagnum squarrulosum* are decapitated by mowing, the stems put out young buds in the neighbourhood of the tufts of branches, each bud possessing a new cone of growth. These buds develope tufts of branches, which for a time derive their nourishment from the parent stem, but soon acquire the power of carrying on existence as separate individuals. This property, together with that of indefinite apical growth, give to the turf-mosses an almost unlimited power of development and reproduction, if only they are supplied with sufficient moisture.

Fungi.

Action of Light on Fungi.†—Professor Karl Regel states that *Pilobolus crystallinus* and *Mucor mucedo* exhibit positive heliotropism in white light, and also in mixed blue and mixed red rays. In one-coloured red light *Pilobolus* also exhibits positive heliotropism. Mixed blue rays produce a much greater heliotropic effect on both species than mixed red rays. Neither the intensity of the light nor the temperature exercises any influence on the kind of heliotropism. While sunlight promotes the development of spores and rapid growth, darkness arrests both. The strongly refrangible are more favourable than the less refrangible rays for both these processes. The hyphæ grow more rapidly in length in white light than in darkness; the less refrangible rays are more favourable to this process than the more refrangible. The formation of sporangia and of spores takes place perfectly normally in *Pilobolus* both in white and in mixed blue and red light, and also in darkness; but most rapidly in white light, next in blue, next in red, and most slowly in darkness.

Chemical Nature of the Cell-wall in Fungi.‡—It is well known that the substance of which the cell-membrane in Fungi is composed does not display the ordinary reactions of cellulose; and it has hence been described as a peculiar substance, under the name "Fungus-cellulose." Karl Richter has determined that this view is incorrect,

* Bot. Centralbl., viii. (1881) pp. 219–20.

† St. Petersburger Naturf. Gesellsch., 1881 (Russian). See Bot. Centralbl., viii. (1881) p. 131.

‡ SB. K. Akad. Wiss. Wien, lxxxiii. (1881).

and that the reason of the failure of the ordinary reactions is the intimate mixture of the cellulose with a foreign substance. In order to eliminate this, it is necessary to treat it for a prolonged period—in some cases several weeks—with potash, and then to wash with a weak acid, after which the blue colouring with chloriodide of zinc is obtained. This treatment was successful with *Agaricus campestris*, *Polyporus Ribis* (?), and *fomentarius*, the sclerotia of ergot, and some lichens; with *Mucor* and *Saccharomyces* it has not hitherto been fully successful; with *Dædalea quercina* the application, in addition, of Schultze's maceration was necessary.

With regard to the nature of the substance which prevents the cellulose-reaction, the author determined, in *Dædalea* and other instances, the presence of suberin, by the formation of insoluble cereinic acid or treatment with nitric acid and potassium chloride. In the mushroom he believes he has also determined the presence of proteinaceous substances.

"Mal nero" of the Vine.*—The vines in the South of Europe, and especially in Sicily, and South Italy, have been attacked, since 1863, by a disease known as "mal nero," which has inflicted great injury upon them; but its exact nature has not heretofore been determined. At the instance of the Italian Government, G. Cugini has now undertaken its investigation, and with the following results:—

The presence of the disease is indicated by the appearance, in the spring, of black streaks and spots on the branches, leaf-stalks, and veins, and on the tendrils and stalks of the branches, penetrating internally to the duramen. It must not be confounded with the anthracnose (*vajolo*) caused by *Glœosporium ampelophagum* (*Sphaceloma ampelinum*).

The disease is caused by a parasitic fungus, a variety of *Sphæropsis Peckiana* Thüm. In the interior of the diseased stems and branches was found abundance of a brown mycelium, which developed especially in the cambium, and between the epidermis and cork-layer. In the parenchymatous tissue of the bark and wood was also found a great quantity of a yellowish-brown granulation, the exact nature of which was not determined. The particles appear to be crystals of calcium tartrate, the result of a hindering effect produced by the fungus on the assimilation of the food-materials absorbed through the root. They are found chiefly in the roots, leaf-stalks, and branches, where the mycelium is comparatively speaking absent.

Roesleria hypogæa parasitic on the Vine.†—G. Le Monnier has found a disease of the vine closely resembling that caused by phylloxera, to be produced by a parasitic fungus which he identifies with *Roesleria hypogæa* v. Thüm. But since that genus was founded on the special form of the spores (which Le Monnier does not

* G. Cugini, 'Ricerche sul Mal nero della vite.' 25 pp. (3 pl.). Bologna, 1881. See Bot. Centralbl., viii. (1881) p. 147.

† Bull. Soc. Sci. Nancy, xiii. (1881) p. 69. See Bot. Centralbl., viii. (1881) p. 47.

confirm), and on the absence of paraphyses, which, however, are present, though difficult to make out, he considers that the genus must be suppressed, and the species arranged under the old genus *Vibrissœa*.

Didymosphæria and Microthelia.*—The identity had been suggested † by Dr. Rehm of the genus *Didymosphæria* of Pyrenomycetes with *Microthelia* of lichens, and the suppression of the former in favour of the latter and older name. G. v. Niessl is unable to accept this view; but regards the former as a true genus of Pleosporeæ, a family made up of genera characterized as under:—

1. *Physalospora.* Spores (ascospores) one-celled.
2. *Didymosphæria.* Spores two-celled.
3. *Leptosphæria.* Spores multicellular, septated transversely only, arranged in one or more rows in the asci.
4. *Raphidophora.* Spores multicellular, septated transversely, arranged in threads or clusters in a straight or coiled bundle in the asci.
5. *Pleospora.* Spores multicellular, septated transversely and longitudinally.

Peronosporeæ and Saprolegnieæ.‡—Professor A. de Bary gives a very detailed description of the sexual and non-sexual organs of the various species included under the Peronosporeæ and Saprolegnieæ.

Pythium de Baryanum is much the most widely distributed of the Peronosporeæ, its thallus being very abundant in living tissues, and in the intercellular spaces, not only in Cruciferæ, but in plants belonging to widely separated natural orders. It is a true parasite, and extremely destructive to the host; but it occurs also in great abundance in the soil, in the form of mycelium, resting conidia, and oospores. It is characteristic of the species that in the formation of the zoosporangia and resting conidia, adjoining portions of the thallus are nearly or entirely and permanently deprived of their protoplasm; the emptied portion usually becoming separated off by a septum. The resting conidia resemble the zoosporangia in every respect except the formation of the neck and of the zoospores. The average diameter of the oogonia is 21–24 μ, and of the oospores 15–18 μ. As soon as the fertilizing tube is formed which carries the contents of the antheridium to the oogonium, the protoplasm in the former separates into two layers, a denser granular central layer which de Bary calls "gonoplasm," and a less dense, nearly homogeneous parietal layer, the "periplasm." The former only appears to participate in the actual process of impregnation.

P. vexans de By. occurs in tubers of the potato which have been partially destroyed by *Phytophthora*, and is closely related to, but apparently not identical with, *P. Equiseti*, found by Sadebeck on the

* Hedwigia, xx. (1881) pp. 161–6.
† See this Journal, iii. (1880) p. 314.
‡ A. de Bary, 'Beiträge zur Morph. u. Phys. der Pilze,' Frankfurt a. M. 1881, pp. 1–71 (6 pls.); and Bot. Ztg. xxxix. (1881) pp. 521–30, 537–44, 553–63, 569–78, 585–95, 601–9, 617–25 (1 pl.).

prothallium of *Equiseta* and on potatoes. The oogonia and oospores are smaller than those of *P. de Baryanum*, the former measuring 15–18 μ, the latter 12–15 μ. It also differs in the mode of germination, and in the abundant formation of zoospores from the freshly formed oospores. It also shows no indication of its thallus penetrating the living tissue of the host; it is a saprophyte, not a parasite.

P. megalacanthum n. sp. is found, along with the first species, on cress; but only on tissue which is already dead, and is hence not a true parasite. The zoospores are of comparatively large size, having an average diameter of 18–20 μ after coming to rest; and 12–15 or more are formed in a zoosporangium. The oogonia are characterized by a large number of vertical conical protuberances, averaging about one-half the length of the radius of the oogonium. The formation of oogonia and oospores takes place chiefly within the tissue of the host. There is a less sharp distinction between gonoplasm and periplasm.

P. intermedium n. sp. is also saprophytic on *Lepidium* and *Amaranthus*. The conidia are formed in rows of from 2–5 by successive abstriction, in a manner different from that known in any other species of *Pythium*. The author has at present failed to detect oogonia and antheridia.

P. proliferum appears on dead insects floating in water that contains algæ; it does not attack living plants. This species closely resembles *P. de Baryanum* in its general morphology, and in the size of the oogonia and oospores. It is characterized by the successive formation of new zoosporangia by a process of prolification. A slightly different form, possibly permanently distinct, is named by the author *P. ferax*.

All the species of *Pythium* hitherto described have more or less globular zoospores; in *P. monospermum*, *reptans*, and *gracile*, the zoosporangium is filiform, the zoospores being formed in the terminal cell of an ordinary branch of the thallus.

P. gracile occurs in dead flies, in water that contains algæ, and can be cultivated on dead plants of *Lepidium* or *Camelina*. The oogonia are very minute, and are formed only in and between the cells of the dead plant. On warm days in summer the oospores are mature in from 24–48 hours after fecundation, and remain then for months in a resting condition. The other forms with filiform zoosporangium are exceedingly similar, and perhaps identical, but appear to be truly parasitic.

Associated with the species already described, and especially with *P. de Baryanum*, there is commonly found one with spiny oogonia, described by Montagne and Berkeley under the name *Artotrogus hydnosporus*. This is the foundation of Montagne's genus *Artotrogus*, formed, as de Bary thinks, on insufficient grounds, chiefly from the negative character of the absence of zoospores, and he proposes for it the name *Pythium Artotrogus*. The antheridia are never, the oogonia rarely, formed from terminal cells of the branch.

Phytophthora omnivora is a parasite on a large number of healthy plants, rapidly killing them, especially in wet seasons, or when otherwise well supplied with moisture, and then living as a

saprophyte on the dead tissues, or on dead animals. The oogonia appear to be produced only under water, and only on some of its vegetable hosts. Experiments completely failed to infect the potato or tomato with this species, which de Bary identifies with Hartig's *P. Fagi*, which produces the destructive disease on seedling beeches,* with Schenk's *Peronospora Sempervivi*, and probably with Cohn's *P. Cactorum*. This species agrees in all essential points of structure with the well-known *P. infestans*. The conidia or zoosporangia are considerably larger than in that species, but vary in size, the average length being about 50–60 μ, and the average breadth about 35 μ; their granular protoplasm is of a darker colour. The ripe oogonia are spherical, with a thick, smooth wall, and smaller than in most species of *Peronospora*, about 24–30 μ in diameter. They are usually terminal, and are produced on lateral swellings or branches. In the process of fecundation there is not, as in *Pythium*, the formation of any distinct gonoplasm-layer. This species agrees with *P. infestans* in the peculiarity which distinguishes the latter from all others of *Peronospora*, viz. the successive formation of several conidia on one conidiophore. The two species are, however, undoubtedly distinct, and in all probability the unknown oospores of *P. infestans* resemble those of *P. omnivora* in their smooth surface, and in other particulars. Although the name *P. Cactorum* has the claim of priority for this species, de Bary prefers the more descriptive *P. omnivora*.

In *Peronospora* the history of development of the sexual organs is very similar to that in *Phytophthora*. There is no evident passage of any considerable quantity of protoplasm from the fertilizing tube to the oosphere.

In the species of *Saprolegnia* belonging to the *ferax* group (including *S. monoica*, *Thureti*, and *torulosa*), the oogonia are as a rule terminal on primary or lateral branches. Here also no passage of protoplasm from the fertilizing tube into the oosphere was ever observed. The mutual function of the two organs appears to consist simply in their close contact, and movements of the protoplasm in each of the organs. The tube puts out an appendix which creeps in a sinuous course over the surface of the oosphere; it at length loses its protoplasm, and finally disappears altogether. When an oogonium contains several oospheres, the tube grows from one to another of them (except in the case of *S. torulosa*), and the same process is repeated in each case. In *S. Thureti* and *torulosa* instances frequently occurred of oospores ripening without any contact with the antheridia.

S. asterophora, distinguished by its spiny oogonium, differs in no important point from *S. monoica*. Here again no opening could be detected at any time in the fertilizing tube. Normal oospores are occasionally formed without the co-operation of antheridia.

Achlya prolifera and *polyandra* resemble one another in all essential points. The development of the oogonia presents no essential difference from that in *Saprolegnia monoica*. The most important distinction is that in *Achlya* the protoplasm of the

* See this Journal, ii. (1879) p. 923.

oogonium, before and during the rounding off of the oospheres, is much more coarsely granular and hence less transparent than in *Saprolegnia.* The oospheres are smaller; their number always two or more. No opening of the fertilizing tube is apparent, and its contact with the oosphere is less intimate than in *Saprolegnia.* The oospheres sometimes become invested with a cell-wall when the antheridia have not put out any tubes.

De Bary describes a new species *A. spinosa*, nearly allied to *A. cornuta*, and presenting a very close resemblance to *Saprolegnia asterophora.* It is characterized by the rarity of the production of reproductive organs, especially of zoosporangia. Ripe oospores are occasionally produced without contact from antheridial tubes.

Aphanomyces scaber presents no special point of difference from the other genera of the family as regards the mode of reproduction. The oospores are here also sometimes produced parthenogenetically.

In all the genera described, with the exception of *Achlya*, the structure of the ripe oospore is the same, having a wall consisting of a thicker epispore and a thinner endospore, which encloses a peripheral layer of granular protoplasm, interrupted by a clear speck, and globules of oil. In *Achlya* there is no "fertilization speck." In all, the oospore is often matured without the production of antheridia and fertilizing tubes. In *Pythium*, *Phytophthora*, and *Peronospora*, there is a distinct "periplasm." In *Achlya*, when germination begins, the globule of oil has altogether the appearance of a granular ball of protoplasm. The germinating tube is clothed with a prolongation of the innermost layer of the wall. The entire elongated oospore then becomes a zoosporangium; or the germinating tube does not directly produce zoospores, but, on reaching a suitable substratum, developes into a vegetating thallus of normal size and form, which then produces both zoospores and oogonia; or it may branch and produce several zoosporangia. In some species all three modes of germination occur, while others are limited to one of them.

De Bary considers that the Peronosporeæ and Saprolegnieæ must be retained as two distinct groups, with this as their essential distinction. In the former the oosphere is formed out of a part only of the protoplasm of the oogonium, and is fertilized by the evident absorption of a portion of the protoplasm which passes out of the antheridium; while in the Saprolegnieæ the oosphere or oospheres are formed out of the entire protoplasm of the oogonium; their actual fecundation by contact with the contents of the antheridium has in no case been detected, and in some cases certainly does not take place. The original *Pythium monospermum* of Pringsheim does not agree with the above character, but no doubt from error of observation.

The genera will then be arranged as follows:—

I. Peronosporeæ. *Pythium* or *Artotrogus* (including *Cystosiphon* Cornu), *Phytophthora*, *Peronospora* (including *Basidiophora* Cornu), *Sclerospora* Schröt., *Cystopus.*

II. Saprolegnieæ. *Saprolegnia* (= *Diplanes* Leitgeb), *Dictyuchus*, *Achlya*, *Aphanomyces.*

Of the Peronosporeæ, *Phytophthora* comes nearest to the Sapro-

legnieæ, while *Pythium* and *Cystopus* are the most remote from them.

Lagenidium, *Myzocytium*, *Ancylistes* Pfitz., and similar forms come very near to *Pythium*, but are distinguished by their production of oospores or zygospores, and may be comprehended for the present under Pfitzer's name Ancylisteæ. *Rhipidium* and *Monoblepharis* are also nearly related to the Peronosporeæ and Saprolegnieæ; the position of the former is uncertain, its mode of fecundation not being at present accurately known; while the latter genus must form by itself the separate group of *Monoblepharideæ*.

Fungi in Pharmaceutical Solutions.*—O. Binz states that the occasional presence of the lower fungi in pharmaceutical solutions is due to the presence of free sulphuric acid, which furnishes the sulphur without which the albuminoids of the fungi in question could not be formed. They withdraw from the sulphuric acid first the oxygen and then the sulphur.

Vegetable Organisms in Human Excrements.†—H. Nothnagel describes the microscopic organisms found in upwards of 800 specimens of human excrements.

Some form or other of bacteria was always found whether the excrements were normal or pathological. The most abundant were sphærobacteria or micrococci, and especially *Bacterium termo*, and these were usually present in enormous quantities; when thin and watery usually in the rod form, when firmer usually in the globular form. All the forms are coloured yellow or yellowish-brown by iodine. *Bacillus subtilis* was also usually found; as also *Saccharomyces*, especially in the excrement of infantile diarrhœa; the most common form resembled *S. ellipsoideus*.

In addition to these, other forms were found which had not hitherto been recognized in the intestines, distinguished by being coloured blue by iodine. The largest of these appeared identical with Prazmowski's *Clostridium butyricum*, the abundance of which was in proportion to the amount of vegetable remains in the excrements. Another smaller form was apparently either a *Clostridium* or Hansen's *Mycoderma Pasteurianum*.

Saccharomyces apiculatus.‡—The first part of E. C. Hansen's researches on the physiology and morphology of alcoholic ferments is occupied with the life-history of *Saccharomyces apiculatus*, with the special object of determining in what form it exists in the periods intervening between its periodical appearances on ripe fruits, gooseberries, cherries, plums, &c., in the summer. The species presents special facilities for this purpose, in consequence of its specific characters being more distinctly marked than those of any other ferment.

Hansen affirms that *S. apiculatus* is found in the summer on ripe

* Wiener Medicinische Presse, 1880. See Bot. Centralbl., viii. (1881) p. 174.
† Zeitsch. für klin. Med., 1881 (1 pl.).
‡ Meddel. fra Carlsberg Labor., 1881, pp. 159–84 (3 pls.). See Bot. Centralbl., viii. (1881) p. 6.

sweet succulent fruits, rarely on unripe fruits or in other localities; from these it is spread by the wind. By rain or the falling of the fruit it is carried to the ground, where it hibernates, repeating the cycle in the next summer.

S. apiculatus produces two kinds of gemmæ, the typical citron-shaped, and others more or less oval, the former being produced earlier, the latter later. Its power of fermenting is much less than that of *S. cerevisiæ*, producing only one volume of alcohol where that species would produce six. It differs from other species of *Saccharomyces* in this respect, that it does not produce invertin, and therefore cannot invert saccharose, nor cause alcoholic fermentation in a solution of it. It exerts an unfavourable influence on the production of *S. cerevisiæ.*

Etiology of Malarial Fevers.*—Dr. G. N. Sternberg was instructed by the National Board of Health (U.S.A.) to repeat the experiments of Klebs and Tommasi-Crudeli made near Rome, whereby they believed they had discovered *Bacillus malariæ.*

The author carried out his experiments in the vicinity of New Orleans, where a great number of minute algæ, including bacteria of various forms, are found upon the surface of swamp-mud, as well as in the gutters within the city limits.

Many of these forms may be successfully cultivated in fish-gelatine solution (method of Klebs), and this fluid, previously innocuous, was found, as the result of inoculation with the organisms, to acquire pathogenic properties obviously due, directly or indirectly, to the presence of the bacteria; for, if they are excluded, the fluids may be kept indefinitely without undergoing change, and are innocuous when injected beneath the skin of a rabbit.

Some of the organisms from swamp-mud, gutter-water, and human saliva were found to be capable of multiplying within the body of a living rabbit, and the fluids and organs containing them (blood, serum from cellular tissue, spleen, &c.), possess virulent properties. In other words, an infectious disease is produced which may be transmitted from animal to animal by inoculation. There were some which closely resembled and, perhaps, are identical with the *Bacillus malariæ;* but there is no satisfactory evidence that these, or any other of the bacterial organisms found in such situations, when injected beneath the skin of a rabbit, give rise to a malarial fever corresponding with the ordinary paludal fevers to which man is subject.

The evidence upon which Klebs and Tommasi-Crudeli have based their claim of the discovery of a *Bacillus malariæ* cannot, the author considers, be accepted as sufficient; (*a*) because in their experiments and in his own the temperature-curve in the rabbits operated upon in no case exhibited a marked and distinctive paroxysmal character; (*b*) because healthy rabbits sometimes exhibit diurnal variations of temperature (resulting apparently from changes in the external temperature), as marked as those shown in their charts; (*c*) because changes in the spleen such as they describe are not evidence of death

* 'National Board of Health Bulletin,' Supplement No. 14. Washington, 23rd July, 1881. 11 pp. and 4 pls.

from malarial fever, inasmuch as similar changes occur in the spleens of rabbits dead from septicæmia produced by the subcutaneous injection of human saliva; (*d*) because the presence of dark-coloured pigment in the spleen cannot be taken as evidence of death from malarial fever, inasmuch as this is frequently found in the spleen of septicæmic rabbits.

While, however, the evidence upon which Klebs and Tommasi-Crudeli have based their claim to a discovery is not satisfactory, and their conclusions are shown not to be well founded, there is nothing in Dr. Sternberg's researches to indicate that the so-called *Bacillus malariæ*, or some other of the minute organisms associated with it, is not the active agent in the causation of malarial fevers in man. On the other hand, there are many circumstances in favour of the hypothesis that the etiology of these fevers is connected, directly or indirectly, with the presence of these organisms or their germs in the air and water of malarial localities.

The truth or falsity of this hypothesis can only be settled by extended experimental investigations; and while further experiments upon animals may lead to more definite results, it seems probable that the *experimentum crucis* must be made upon man himself, isolating and cultivating the various organisms found in malarial localities, and experimentally investigating the physiological action of each when taken into the stomach or respired in a dry state by healthy individuals. The converse method should also be tried of studying the bacterial organisms found in the mouth and alimentary canal of persons suffering from malarial fever, compared with the common forms found in the same situation in the healthy state.

Aktinomykosis, a new Fungoid Cattle-Disease.* — Under the name Aktinomykosis or Strahlenpilzerkrankung, Johne describes an infectious disease which attacks the tongue, throat, &c., of cattle, and which he attributes to a hitherto undescribed bacterial organism to which he gives the name *Aktinomyces*. The author is not able to assign a systematic position to this organism. It commences with an unseptated mycelium, probably originating from micrococci, which swell up into pear- or club-shaped conidia. When collected into masses it not unfrequently becomes hard and calcified.

Infection by Symptomatic Anthrax.†—Messrs. Arloing, Cornevin and Thomas give some results of their intravenous method of inoculation ‡ applied under the authority of the French Government, and of other methods which they have tested. Of these other methods (1) that by the digestive passages has not hitherto been found to produce the disease; (2) that by the respiratory cavities causes a merely abortive malady; (3) that by injection into the connective tissue (either dermal, subcutaneous, or intramuscular) of infinitesimal quantities of virus results in abortive symptoms; with a medium dose, a trifling local disturbance is set up, but more lasting general effects are also produced

* Deutsch. Zeitschr. für Thiermed., viii. (1881) pp. 143–92 (3 pls.). See Bot. Centralbl., vii. (1881) pp. 338.

† Comptes Rendus, xcii. (1881) pp. 1246–9.

‡ See this Journal, i. (1881) p. 95.

in the form of one or more symptomatic tumours at points remote from the place of inoculation; with a very strong dose a tumour immediately appears at this point, the general condition of the patient becomes rapidly serious, and if life lasts sufficiently long, one or more tumours may arise in different parts of the muscles. (4) The results of the intravenous process of injection similarly differ with the amount of virus employed. With a minute quantity general disturbances are produced, which disappear in two or three days, leaving the subject proof against the effects of further inoculation; this is caused by an abortion of the anthrax. With a considerable dose, symptomatic anthrax is fully developed, and tumours appear, invariably causing death.

These different modes in which the poison may be seen to act are thus explained. In the case in which intravenous injection is not fatal the bacterium probably multiplies in the blood, but is prevented by the endothelium of the vessels from entering the connective tissue. The serious consequences which always follow introduction of the poison into the latter tissue—extending to the production of a local tumour, even after a preventive inoculation by intravenous injection—show this to be really the point at which the virus attacks the system. When tumours follow intravenous injection, the bacterium must have passed in some way into the connective tissue, whether by rupture of other coats or otherwise. The abortive result of inoculation by way of the respiratory system, as well as by way of the veins, is due to the same cause, viz. the penetration into the blood of the bacterium through the lining-epithelium and its development in this harmless position.

A short account of some public experiments performed by the same three investigators at Lyons is given by Bouley.* The first series were intended to show immunity against symptomatic anthrax produced by previous intravenous inoculations at different periods. Thus a ram inoculated in the thigh with 5 cc. of the virus died in two days, but a calf, vaccinated fourteen months previously by intravenous injection, showed not the smallest sign of evil effects after injection of 1 mm. in the same manner as in the former case; the same immunity was exhibited by another calf inoculated with 5 mm. eleven months after vaccination; so also with a calf sixteen days old whose mother had been inoculated twenty-seven days after the commencement of gestation (six months before the birth of the calf). An ewe, vaccinated fifteen days previously by injection into the trachea, behaved similarly on injection of 5 mm. into the thigh. A second series of experiments showed the refractory behaviour of certain animals towards the disease; thus subcutaneous and intramuscular injections produced no effects on a pig, a white rat, a dog, and a rabbit, but the same operation performed at the same time killed a six months' calf.

The method of vaccination here adopted differs from that employed by Pasteur against the other form of anthrax (bacteridian anthrax) in not employing a mitigated form of the virus, but introducing the virus in its natural condition into surroundings (i.e. the blood-vessels) not so

* Comptes Rendus, xcii. (1881) pp. 1383-7.

favourable to its development as other parts of the body. The value of the method has been proved by the subjection of 244 animals to its action.

Experiments on Pasteur's Method of Anthrax-Vaccination. *— In his own name and the names of Messrs. Chamberland and Roux, L. Pasteur gives a summary report of a series of experiments made by them in May and June 1881, near Melun (Seine-et-Marne), at the request of the Agricultural Society of that place, in order to demonstrate the vaccinating power of a modified form of anthrax virus, as already described.†

Fifty-eight sheep, of different breeds, ages, and sexes, two goats, eight cows, a bullock, and a bull having been placed at their disposal, they set aside 10 of the sheep and inoculated 24 of the remaining 50, together with 1 goat and 6 cows, with a mitigated form of anthrax virus, and then, after 12 days, with a stronger solution. After a further interval of 14 days, the 31 vaccinated animals, together with the 24 sheep, 1 goat, and 4 oxen still remaining unvaccinated, were inoculated with a very deadly form of anthrax virus, vaccination being carried out alternately on vaccinated and unvaccinated animals. The company, including numerous local and departmental authorities and professional men, were assembled after two days to witness the results of the experiments. All the subjects of the preliminary inoculation were found, to all appearance, in good health (one died subsequently from a cause other than anthrax), but of the others, 21 sheep and the goat had already perished from the disease, 2 more sheep died in the presence of the spectators, and the twenty-fourth died at the close of the day. None of the oxen died, but all developed large swellings round the point of inoculation, and their temperature rose 3°. A large number of those present expressed their conviction of the importance of the method adopted.

Professor Milne Edwards ‡ has compared some of the facts brought forward by M. Pasteur with the phenomena of alternation of generations exhibited by some *Hydrozoa*, and suggested that experiments should be made to ascertain whether in this case, as in that of the septic organisms described by M. Pasteur, variations in the temperature or in the amount of air dissolved in the water, might be made to produce whichever stage of these animals might be required.

Some experiments, as reported by Bouley,§ were also made publicly at Chartres, with the view of testing the principles laid down by M. Pasteur, and supported by his experiments at Melun. They differ from those experiments in employing infected blood for the inoculations instead of artificial growths of the virus. Thus 19 sheep already inoculated, together with 16 which had not been inoculated, were all injected with half a syringeful each of a mixture of blood and splenic pulp taken from a sheep which had just died of anthrax; 15 of the 16 unvaccinated sheep died within 3 days of the operation; the 19 which

* Comptes Rendus, xcii. (1881) pp. 1378–83.
† See this Journal, i. (1881) p. 499, &c.
‡ Comptes Rendus, xcii. (1881) p. 1383.
§ Ibid., xciii. (1881) pp. 190–2.

had been vaccinated showed no sign of ill-health. The method of vaccination is thus proved to be as efficacious against virus produced naturally as against that produced by artificial means.

Duration of Immunity from Anthrax.*—H. Toussaint bears testimony to the finality of M. Pasteur's recent investigations on this subject. He draws attention to one or two minor points yet unsolved, viz. the *duration* of the immunity against the disease, and the *power of inheriting* this immunity which is possessed by animals. The duration is said to vary directly with the severity of the first attack, and inversely with the resistance of the animal to the disease; for certain lambs and ewes which had suffered severely from the effects of a first inoculation had preserved their immunity up to the time of writing (12 months), and the ewes had transmitted it to their offspring; while of certain 20-month lambs and old ewes which were first vaccinated with a weaker virus than in the preceding case, and which had resisted an inoculation made a month later, some of the ewes were overcome by the effects of a third inoculation made four months later, while the 20-month lambs survived. The fact of inheritance of the immunity is shown by the absence of any evil results of inoculation of lambs of one month which were born of vaccinated ewes; this is a genuine case of inheritance, which cannot be said with equal truth of lambs born of parents inoculated during gestation, for in this case the lamb *in utero* forms practically part of its parent.

New Method of Vaccination for Fowl-cholera.†—H. Toussaint supplements M. Pasteur's researches in this subject by experiments showing new methods of mitigating the virulence of the poison, and confirming his own previous opinion as to the identity of septicæmia and fowl-cholera. In one case rabbits inoculated with blood infected with anthrax died in 7 or 8 hours of septicæmia, pigeons died from its effects in from 1 to 4 or 5 days, fowls inoculated from the pigeons also in from 1 to 4 or 5 days. The bacterium of the disease exactly resembles that of fowl-cholera, and all the symptoms and lesions are precisely similar with both the diseases. In another set of experiments, consisting in inoculating fowls directly with blood from rabbits which had died of septicæmia, the fowls were not killed, but proved to have undergone a vaccinating action, being afterwards proof against both fowl-cholera and septicæmia. To secure this result it is only necessary to vaccinate at the end of the wing. M. Toussaint is inclined to explain the fowl-cholera as produced by certain bacteria whose development is favoured by the presence of putrefying organic matter.

Rabies.‡—This obscure subject has been now approached by the famous experimenter on germ-diseases, L. Pasteur, in conjunction with Messrs. Chamberland, Roux, and Thuillier. The view long supported by Dr. Duboué, that the central nervous system, and above all the medulla oblongata connecting the spinal cord with the cere-

* Comptes Rendus, xciii. (1881) pp. 163–4.
† Ibid., pp. 219–21.
‡ Ibid., xcii. (1881) pp. 1259–60.

brum and cerebellum, is the seat of the development of the disease, had been disputed by Prof. V. Galtier, who found indications of virus only in the lingual glands and on the mucous membrane of the mouth and pharynx, and not in the above-named parts of dogs affected with the disease. Pasteur and his companions have, however, often successfully inoculated the medulla oblongata, the cerebro-spinal fluid, and the frontal portion of one of the hemispheres. The period of incubation before manifestation of its effects has hitherto been found to be uncertain, and often long, but this period can now be diminished by inoculating the surface of the brain directly with pure brain substance removed from a mad dog: in this case, the symptoms of madness, either under its silent or furious form, appear within a fortnight of the operation, and death ensues in less than three weeks from the same date. This method has never—as in so many other cases—failed in producing the disease.

The results of some experiments * with the active elements of rabies have led Prof. Galtier to some important conclusions. Six sheep and four rabbits inoculated at different times with this poison by hypodermic injection all died from its effects; while out of nine sheep and one goat inoculated by intravenous injection none succumbed, but on the contrary, all successfully resisted the effects of subsequent inoculations. Of five rabbits which received as a draught some saliva infected with virus and mixed with water, only two died. The conclusions deduced are:—(1) Intravenous injection of the poison of rabies into sheep does not produce the disease, but seems to confer immunity against it; (2) introduction of the poison into the digestive organs is fraught with danger. Galtier has reasons for suspecting that intravenous injection, practised the day following a bite or inoculation, or even the next day, will prove effectual in warding off the malady.

Lichenes.

Nutrition of Lichens.†—G. Egeling disputes the statement that when lichens grow on apparently smooth surfaces, as quartz, glass, &c., they are true "epiphytes." On even the smoothest surface, there are always irregularities which allow of the accumulation of dust; and from the substances which collect in this way, the lichen obtains its nutriment, until it is able to decompose the hardest and smoothest substances, even glass or oxide of iron.

Thallus of Usnea articulata.‡—According to A. Jatta, the thallus of this lichen consists of three distinct layers, viz. (1) a central, continuous, compact, elastic, very resistant tissue, the *medullary layer;* (2) a much laxer and readily distinguishable tissue, composed of branched hyphæ and gonidia, the *gonidiferous* layer; and (3) a membranous sheath, very delicate and almost inelastic, the *cuticular layer.* The interrupted or jointed thallus, characteristic of the species, is the result of the unrolling of the spiral of the medullary filaments, which causes their rapid elongation, in contrast to the very slight

* Comptes Rendus, xciii. (1881) pp. 284–5.
† Oesterr. Bot. Zeitschr., xxxi. (1881) pp. 323–4.
‡ Nuov. Giorn. Bot. Ital., xiv. (1882) pp. 53–9.

elasticity of the cuticular layer and the looseness of the gonidiferous layer.

The author objects to the ordinary term "gonidial layer" as applied to lichens, seeing there is no distinct layer composed entirely of gonidia. The gonidia of *Usnea articulata* are of the form referred by Bornet to *Protococcus*. In the older part of the thallus they are perfectly free from hyphæ, and are grouped in various ways in the outer part of the gonidiferous layer; but in the younger part of the thallus the hyphæ are composed of shorter cells and assume a more contracted appearance, and the gonidia are often to be found adhering to their apices.

Algæ.

Symbiosis of Lower Animals with Plants.*—The relations which subsist between the different organisms which live upon, or within each other, are very various; for the one, in its capacity of parasite or companion or guest of the other, exercises on its host an influence which is in some cases injurious, and in others advantageous to the vital conditions of the latter. Many instances of this life in common, or *symbiosis*, are known among animals as well as plants, but the cases of symbiosis between animals and plants are less well known; and in regard to these, K. Brandt has made some interesting communications to the Physiological Society of Berlin, of which the following is an extract.

Chlorophyll, which occurs in all plants except the Fungi, is known to occur in the animal kingdom also—in Rhizopoda, ciliate Infusoria, fresh-water Sponges, the tentaculate Polypes, and many marine and fresh-water Turbellaria. In all these the chlorophyll is present in the form of sharply defined, oval, or round granules, identical with its form in plants. Three contradictory views have been held with regard to the presence in animals of chlorophyll: (1) that the green particles are true chlorophyll-granules, (2) that they are not produced by the animals themselves, but must be considered as parasites, (3) that in the case of the Protozoa, at any rate, the green masses are merely parts of vegetable organisms which have been absorbed after being submitted to digestion. Direct observation has not yet decided the question. In his 'Natural Conditions of Animal Existence,' Semper gives a critical sketch of the investigations which have been made, and comes to the conclusion that the green particles should be regarded either as endogenous products of the animal, or as commensals, and he considers the latter opinion the most probable one. The author has accordingly made experiments with microchemical reagents in order to determine whether the green bodies consist simply of chlorophyll combined with a fundamental substance, or whether they contain colourless protoplasm as well, and whether they have a nucleus, and are invested by a cellulose membrane, also whether they are physiologically independent, or continue to live after the death of the animals in which

* Verhandl. Physiol. Ges. Berlin, 1881–2, p. 22. Cf. Naturforscher, xv. (1882) pp. 15–17; and Rev. Internat. Sci. Biol., v. (1882) p. 149–52.

they occur, and whether it is possible to infect an animal which has no chlorophyll, by means of a fragment of one which does contain it.

The morphological investigations were carried out upon *Hydra*, *Spongilla*, a fresh-water Planarian, and a variety of Infusoria. The green bodies were isolated by crushing the animals and were then examined with high powers, and it was found that they are not of a uniform colour like the chlorophyll-bodies of plants, but contain hyaline protoplasm. Treatment with hæmatoxylin always reveals a definite cell-nucleus, and the same is the case if the animals are first killed by 0·2 per cent. chromic acid, or 1 per cent. per-osmic acid, then freed from chlorophyll by alcohol, and finally treated with solution of hæmatoxylin. These characters prove that what have been described as chlorophyll-corpuscles in animals are really unicellular beings, morphologically independent, which Brandt describes as two new genera of Algæ, *Zoochlorella*, and *Zooxanthella*, with several species; the first-named are green, and are met with in animals belonging to the Protozoa, the Sponges, the Hydrozoa and the Turbellaria; the second are yellow, and are found in some Radiolaria, certain Hydrozoa, and some Actiniæ.

Their physiological, as well as their morphological independence can also be established. Thus, if specimens of *Zoochlorella* are isolated, they do not die, but live for some days, and even weeks, and when exposed to the light are able to develope starch-grains. Inoculation-experiments show besides that the species of *Zoochlorella* also differ physiologically *inter se*. Green bodies isolated from *Spongilla* and brought into contact with Infusoria devoid of chlorophyll, although in many cases taken in, were unable to persist in the latter animals; they were either digested or expelled without undergoing any alteration. On the other hand, Infusoria devoid of chlorophyll were successfully inoculated by *Zoochlorellæ* from a dead *Hydra viridis*. Many *Ciliata*, absolutely without green corpuscles, absorbed the parasitic forms of the *Hydra*, and kept them for a long period.

With regard to the question of the origin of the chlorophyll, Brandt concludes that the animal organisms do not themselves produce it, it being found nowhere but in true plants, so that when met with in animals, it owes its existence to parasites. He describes in the following terms the results to which his experiments have led him: "In making use of the expression 'parasites,' for the yellow and green algæ, I have been actuated by the desire of abbreviation, as well as by the fact that morphologically the algæ have almost the appearance of parasites on animals. Physiologically, they cannot be regarded as parasites. They cannot be compared with the parasitic fungi, the *Tæniæ*, &c., for these derive their subsistence from their hosts alone, form no nutrient matter themselves, and give out still less, while the species of *Zoochlorella* and *Zooxanthella* have the power of producing organic materials (water and carbonic acid) themselves, in the same way as true plants. At first sight, one would expect them not to remove organic matters from their host, but rather to supply them to the latter. What, however, really takes place, and to a very large extent, is shown by the following observations:—

"(1) In carefully examining large colonies of Radiolaria, I have not found, either in their gelatinous matter or in its neighbourhood, any foreign bodies which had undergone digestion. Inasmuch as they require, by reason of their very considerable bulk, large quantities of nourishment, and as they are absolutely destitute of any power of manufacturing organic substances out of water, carbonic acid, and ammonia, they cannot be kept alive by any other means than the yellow cells which they harbour in large quantities. (2) I have been able to keep the colonies with ease by placing them in well-filtered sea-water: under these conditions they are deprived of all possibility of nourishing themselves, like true animals, with solid organic substances. (3) I have kept *Spongilla* in filtered river-water for the same length of time. Even when the water has been filtered daily, they have flourished wonderfully. But whenever the vessel was placed in a half-darkened spot, they regularly died. Light is absolutely necessary to them.

"This proves, then, that *Zooxanthella* and *Zoochlorella* contribute to the support of their hosts. As long as the animals contain but few or no green or yellow cells, they are nourished like true animals, by the absorption of solid organic materials; as soon as they contain a sufficient amount of algæ, they are nourished like true plants, by assimilation of inorganic materials. They ought to resume their animal mode of nourishment when the algæ withhold their functions, in the absence of light. They perish if they do not then again adapt themselves to the mode of alimentation which properly belongs to them.

"The researches of botanists have brought to light two different ways in which algæ may live in connection with other vegetable organisms. Firstly, algæ are found living like "lodgers" in other chlorophyllaceous plants. Secondly, according to Schwendener, they live in companionship with fungi, and with them form lichens. In the first case the parasitic algæ usually behave indifferently in relation to the conditions of assimilation adopted by their hosts. The algæ are nourished like the plants in which they live, by assimilation of organic matter. In the lichens, the algæ furnish the nutritive matter to the fungi, which live parasitically upon them. The algæ manufacture organic substances out of inorganic substances, and the fungi utilize them.

"The association of algæ and animals is an analogous case, but nevertheless differs from it. In the green and yellow animals the same phenomenon usually occurs; the algæ manufacture organic substances from inorganic substances, and the animals make use of them. But while in the lichens we find true parasites (fungi) associated with algæ, in the green and yellow animals we find a *symbiosis* of algæ with independent animals, habituated to an independent existence. The animals (Phytozoa as they may be termed) renounce their independent life and allow themselves to be supported entirely by their parasites, when once the green or yellow algæ have entered their tissues and have multiplied there sufficiently. They absorb no more solid organic substances, although they are

perfectly able to do so, but are entirely comparable, from the morphological point of view, to animals devoid of chlorophyll. This life of algæ in common with animals is one of the strangest things which can be conceived. Morphologically it is the algæ which are the parasites, but physiologically the animals."

"Yellow Cells" of Radiolarians and Cœlenterates.*—Mr. P. Geddes was also simultaneously (and independently) working at the same subject as that which had engaged Herr Brandt's attention (forming the subject of the preceding note), and in a communication to the Royal Society of Edinburgh he deals with the vexed question as to the nature of the "yellow cells" also, presenting an interesting aspect of the economic inter-relations of the animal and vegetable kingdoms.

The author's researches on animal chlorophyll had already shown that such animals as *Convoluta*, *Hydra*, and *Spongilla* vegetated by their own intrinsic chlorophyll; and he now shows that certain Radiolarians and Cœlenterates vegetate, as he terms it, "by proxy, by rearing copious crops of Algæ in their own tissues, and profiting by their vital activities." Cienkowski and others have already contended that the "yellow cells" in question were algæ, for the reason, among others, that they continued to live and multiply long after the death of the animal, but the subject was obscured by contradictions. After repeating the observations of Cienkowski on the Radiolarian yellow cells, the author undertook an independent examination, which established their character as true algæ. Not only is their mode of division thoroughly algoid, but starch, as described by Haeckel, is invariably present. The cell-wall is of true vegetable cellulose, and the yellow colouring matter is the same as that of diatoms. In *Velella*, in sea anemones, and in a Rhizostome Medusa (*Cassiopeia borbonica*), similar organisms were found.

Alluding to the methods of examination, Mr. Geddes says that the failures of former observers in obtaining these reactions have been simply due to neglect of the ordinary botanical precautions. Such reactions will not succeed until the animal tissue has been preserved in alcohol and macerated for some hours in a weak solution of caustic potash. Then, after neutralizing the alkali by means of dilute acetic acid, and adding a weak solution of iodine, followed by strong sulphuric acid, the presence of starch and cellulose can be successively demonstrated in the same preparation. "Thus, then, the chemical composition, as well as the structure and mode of division, of these yellow cells are those of unicellular algæ. I therefore propose for this alga the generic name of *Philozoon*, and distinguish four species differing slightly in size, tint, mode of division, &c., to which the names of *P. radiolariarum*, *P. siphonophorum*, *P. actiniarum*, and *P. medusarum*, according to their habitat, may be conveniently applied."

The mode of life and functions of the organisms are fully dealt with. Reminding us that the colourless cells of a plant share the starch formed by the green cells, Mr. Geddes urges that it is impos-

* Nature, xxv. (1882) pp. 303–5.

sible to doubt that when the vegetable cell dissolves its own starch, some must needs pass out by osmosis into the closely enveloping protoplasm of the surrounding animal cell, which possesses abundance of amylolytic ferment. Further, the nutritive functions of the animal gain by digesting the *Philozoon* at its death. On the other hand, the carbonic acid and nitrogenous waste produced by the animal cell are necessities of life to the alga, which in removing them performs an intracellular renal function. Yet further, during sunlight the alga constantly evolves nascent oxygen into the surrounding animal protoplasm, and so we have foreign vegetable chlorophyll performing the respiratory functions of native animal hæmoglobin, and the resemblance becomes closer when we bear in mind that hæmoglobin frequently lies as a stationary deposit in some tissues like the tongue of certain molluscs and the nerve-cord of *Aphrodite* and Nemerteans.

Thus, then, "for a vegetable cell no more ideal existence can be imagined than that within the body of an animal cell of sufficient active vitality to manure it with abundance of carbonic anhydride and nitrogenous waste, yet of sufficient transparency to allow the free entrance of the necessary light. And conversely for an animal cell there can be no more ideal existence than to contain a sufficient number of vegetable cells, constantly removing its waste products, supplying it with starch and oxygen, and being digestible after death. . . . In short, we have here economic inter-relations of the animal and the vegetable world reduced to the simplest and closest conceivable form."

That this is no mere case of parasitism is further proved by the fact that it is exactly those animals containing the algæ ("animal lichens," as the author suggests they might not unfairly be called) which show exceptional success in the struggle for existence, instead of the weakened state to be found in the host of a parasite. They are not only far more abundant, but are capable of enduring greater hardships than their less fortunate allies.

Mr. G. Murray * considers that "to botanists these investigations bear a very peculiar interest. No nearer analogue to this 'consortism,' if it may be called so, of the animal and the vegetable (algal) cell can be found than in that of the fungal and algal cells of the lichens. It is so apparent throughout that it is needless to enter into a detailed comparison. One point in the analogy, however, is noteworthy. The young gonophores of *Velella* which bud off from the parent colony, start in life with a provision of *Philozoon*. One cannot but be forcibly reminded by this of the function of the hymenial-gonidia of such lichens as *Dermatocarpon*, *Polyblastia*, &c., as described by Professor Stahl. The hymenial-gonidia, which are the offspring of the thallus-gonidia, are carried up in the formation of the apothecia, and are cast out along with the spores. Falling in the same neighbourhood, the spores, on germinating, enclose with their filaments the hymenial-gonidia, which ultimately become the thallus-gonidia of the new lichen. The fact that among these animals the most closely allied to each other morphologically differ thus widely physiologically, bears

* 'Academy,' No. 508 (1882) p. 67.

comparison with the near relations of the fungal parts of the lichens with the other ascomycetous fungi."

Cooke's British Fresh-water Algæ.—The existing books on British fresh-water Algæ are so much out of date that a new one will be very welcome to algologists and microscopists. The first part of Dr. M. C. Cooke's work is now published, and contains the Palmellaceæ with 11 coloured plates and 32 pages of text, and is intended to be followed by part 2, the Protococcaceæ and Volvocineæ, and part 3, the Zygnemaceæ. The Desmidieæ and Diatomaceæ are not intended to be included.

Diatoms in thin Rock Sections.—At p. 507 of Vol. I. (1881) we gave an account of a careful study of diatoms from the tolerably hard diatom-rock of Nykjöbing in Jutland, made by W. Prinz from transverse sections of three species:—*Coscinodiscus oculus-iridis*, *C. excentricus*, and *Trinacria regina.* In the first two instances he obtained exceedingly good demonstrations of the encasing of one valve in the other, as also of the various thickness of the valves at different places. In *C. oculus-iridis* he found the hexagonal honey-comb-like meshes to have an opening at the base, the inner cell-layer having a circular perforation in the middle of each cell. In *Trinacria regina* he found the small round dots which cover the entire valve to correspond to canals which completely perforate the thickness of the valve. Whether this is so also in *C. excentricus* could not be determined with certainty, in consequence of the minuteness of the dots.

Prinz's observations differ from those of Flügel, O. Müller, and Green to this extent, that these latter did not observe an actual perforation of the inner layer of the valve, by which the cell-contents might altogether pass out. O. Müller's observations on *Triceratium Favus* were founded on an ingenious method of flooding. In this species and its allies, including *Biddulphia reticulata*, the inner layer of the valve is completely covered by radial rows of fine dots, which are nowhere wanting, and which exclude the presence of larger openings.

It might be assumed that these small dots correspond to canals which perforate the inner layer; but A. Grunow states* that he has examined very large specimens of the variety *sexangularis* of this species, in which this layer was so thick that it was possible, by focussing, to detect the radiating dots on the inner side, and on the outer side irregularly disposed short spines at the base of the honey-comb-like cells, the walls of which were thickened above and sometimes elongated into a spine at the corners. Similar structures occur in *Triceratium Favus* and in *Coscinodiscus*, while *T. consimile* Green, which closely resembles the former, has exactly the structure of *C. oculus-iridis.* In the last-named species a circular depression is found in the inner layer of the valve, but no perforation. At these depressions the valve is very thin, so that it may be completely broken through there by boiling or in other ways. But an "incontrovertible proof" that there is no actual perforation is afforded by the closely allied species *C. Asteromphalus*, connected with it by inter-

* Bot. Centralbl., viii. (1881) p. 354.

mediate forms. The inner side of the valve is here covered with small dots or depressions, which form a circle of larger dots at the margin of the meshes, gradually diminishing in size and becoming scarcely visible towards the interior, but always covering the whole of the base of the meshes. On closer focussing, these minute dots disappear, and appear to be the depressions taken by Prinz for perforations. In *C. gigas* there are found also in the middle only small round depressions which are surrounded towards the margin by a network projecting outwards, so that this species has internally the structure of the punctured forms, externally that of *C. oculus-iridis*, *radiatus*, and similar species. In *Trinacria regina* the depressions always penetrate very deep, as is the case in many diatoms; but at the base of the depressions is a smaller indentation which, when highly magnified, is very clearly seen in the middle of the pore, as occurs again in many diatoms. Grunow has examined a large specimen of this species, in which a further much more delicate and narrower punctation was visible, apparently on the inner surface of the valves. The transverse section which Prinz draws of *C. excentricus* (or more probably of *C. symbolophora*) appears, however, to be correct; and the pore canals are here mostly represented as not completely reaching the inner surface of the valve. If these depressions permit endosmose through them, their thin inner wall can be perforated only by canals so delicate that they are invisible to the highest powers. Grunow promises a treatise on this difficult subject.

Fineness of Striation as a Specific Character of Diatoms.*— Prof. H. L. Smith comments upon the paper of Count Castracane on this subject,† in which, it will be remembered, he arrived at the conclusion that "the striæ and their fineness *are a quality of specific importance*."

Prof. Smith says:—"In a few words appended to the translation of the paper, Mr. Kitton, the well-known English diatomist, criticises Count Castracane's conclusions, and indicates the mistakes of the Count himself in his attempt to make these measurements, which he deems of specific performance. The conclusion of the Count, however, will be heartily welcomed by 'species-mongers,' inasmuch as one need have little fear in being able to sustain the claim to *n. sp.* if allowed to fall back on striation as the test, for who shall decide? Not every one has at command the elaborate apparatus used by Count Castracane for determining the number of striæ. Photographs of each diatom, projections on a large scale, &c., seem to be considered by him as the only trustworthy method; a method of such exactness that it 'enables him to disagree with microscopists of incontestable authority.' For Count Castracane personally, and as a correspondent and a thoroughly conscientious, hard-working diatom student, I have the highest respect, but I am sorry that he has felt himself obliged to adopt so pernicious a view, as it seems to me. The Diatomaceæ belong to the vegetable world, and the principles governing

* Amer. Mon. Micr. Journ., ii. (1881) pp. 221–3.
† See this Journal, i. (1881) p. 787.

their classification and arrangement need not be very different from those accepted for other portions of the vegetable kingdom. It would seem that with as much propriety one might consider the number of granules on a *Staurastrum*, or striæ on the frond of a *Closterium*, of specific importance; or the number of fibres in a given space of a specimen of pine or oak, of value in determination of species. I venture the assertion, that if one were to show to the distinguished microscopist who has advocated this view of the importance of fineness of striation, a slide of diatoms, and request him to say what they were, he would name them all, correctly too, and never once resort to measurement of striation to do so. Now, if this can be done, and it is done every day by experienced microscopists, what is the necessity of bringing in an element which most students of the Diatomaceæ consider very variable and exceedingly difficult to determine. I would not have it understood, by what I have said, that I consider striation as of no importance; in conjunction with other things, it has a certain value, but at best only secondary.

"I do not suppose that Count Castracane would for a moment assert that *Stauroneis Phœnicenteron*, e.g., has the same number of striæ in ·001 of an inch as *Stauroneis gracilis*, and yet I have frequently found the latter conjugating, and the sporangial frustule is *S. Phœnicenteron*. The sporangial frustules of the diatoms are notoriously more coarsely marked than the parent frustules. There are a great many species of diatoms, belonging to the *N. prima* group, which really pass into each other so gradually that, even by the help of striation, it is difficult to distinguish them; *N. affinis* produces, by conjugation, true *N. prima*, and I have even observed the large frustules of the latter again producing monsters, by conjugation, far more coarsely marked than the parent frustules. Shall we consider the sporangial form as one species, and the parent form another?

"I have before me now a slide of *Gomphonema olivaceum* containing myriads of frustules, many conjugating, and some with the parent frustules yet adhering to the sporangium. The comparative striation, as measured with a Powell and Lealand spider-line micrometer, is very nearly as 4 to 6, and as the individual measurements of the parent frustules give for the striation 28 to 30 in ·001 inch, we have for the sporangial ones say about 20 in ·001 inch. In this gathering there are numerous free sporangial frustules wholly formed, and quite as coarsely marked, and apparently numerous others of intermediate size and striation. Of what value would striation be here? What I have said about *G. olivaceum* is equally true of other diatoms, notably of the genus *Cymbella*. And yet in conjunction with other characters the striation should not be ignored. In the same gathering, on *Isthmia enervis*, the striation may be so nearly the same on larger and smaller frustules as to appear to be of specific value; but it by no means follows that it will be the same in this species from a widely different locality, nor does my experience with Eulenstein's preparations of *Isthmia enervis* coincide with that of Count Castracane. I find that the small granules on the connecting zone, or central portion, say in ·001 inch, in the ratio of about 5 to 7, measuring,

however, not with extreme accuracy, yet sufficiently accurately to show quite a latitude in this respect. Taking a pretty sure gathering, made at the time of the year somewhat remote from the time of the conjugation, I am quite prepared to admit that a preparation of the so-called *Frustulia saxonica*, for example, will not show any appreciable difference in the striation of the frustules; but I would be quite unwilling to admit that this diatom could not be obtained from another locality considerably more finely or more coarsely marked; indeed, Count Castracane himself admits a difference, though he says it has never, to his knowledge, exceeded $\frac{1}{5}$, which, as Mr. Kitton shows, gives a range in *N. crassinervis*, if he understands aright, of 27 to 35 in ·001 inch!

"The general character of the striation, parallel, radiate, &c., the character of the median line, if present, the comparative fineness or coarseness of the striæ—all these are, no doubt, important, as is also, within limited range, the number of striæ in ·001 of an inch. Any one looking over Mr. Habirshaw's 'Catalogue of the Diatomaceæ' will realize what a frightful increase of species was made by Ehrenberg and the earlier observers, from considering the number of rays in the genus *Actinocyclus* as of specific value; equally pernicious is the custom too largely indulged in at the present day by many hard-working Continental observers, who, looking from the standpoint which Count Castracane appears to advocate, find at stated intervals new species, founded upon little else than finer or coarser striation, or perhaps somewhat different outline. It is, no doubt, quite a comfortable way of working, and of keeping one's name before the public, when one finds what is supposed to be a new diatom, if only knowing enough to distinguish the genus, one measures, more or less correctly, the length, breadth, or diameter, and the number of striæ in ·001 of an inch, giving sometimes a representation, which if it be one of the smaller *Naviculæ*, may too often equally well represent many other forms, and, finally, to coin some unpronounceable word, or immortalize some friend, and send forth the bantling; since nobody can venture to question its legitimacy, for does it not differ somewhat from every form hitherto figured or described in outline? And has it not a few more or less striæ in ·001 of an inch? I shall be sorry if, in what I have said, I am considered as censuring men who are unquestionably hard-working and conscientious students of these interesting little organisms. I am only regretting that, instead of labouring to reduce the genera and species of the Diatomaceæ, and seeking for broader and firmer principles to guide in their study and classification, so many worthy persons are contented to accept trivial distinctions as of generic and specific value, and they are so encumbering the subject, that some day it will be crushed by its own dead weight, giving place to a new structure, utilizing as far as possible the ruins, but erected upon a more solid foundation."

Schmidt's Atlas of the Diatomaceæ.*—The recently published parts of this work treat of the following genera:—*Coscinodiscus*,

* A. Schmidt, 'Atlas der Diatomaceenkunde,' Heft 17 u. 18 (8 pls.) Aschersleben, 1881.

Craspedodiscus, *Auliscus*, *Pseudoauliscus*, *Arachnoidiscus*, *Naviculæ* belonging to the groups Didymæ and Lyræ, *Cymbella*, &c.

In *Gomphonema Mustela*, the author states that the frustules, after they have become reduced, by repeated division, to the smallest dimensions, leave their pedicel and attach themselves together, in a reverse position with respect to one another, by their ventral sides; from which he deduces an argument in favour of the animal nature of diatoms.

In the Cymbelleæ, in which the reproduction of *Cymbella gastroides* and *Cocconema Cistula* is delineated, the author believes that there is also, as in *Gomphonema*, a distinction between the upper and under part of the frustule; and supposes that, when conjugating, they also attach themselves to one another in a reverse position. The unsymmetrical arrangement of the cell-contents of several species of *Navicula*, already pointed out by Pfitzer, is illustrated by drawings of *N. dicephala;* and the inference is drawn that all species of *Navicula* present a difference between the anterior and posterior ends, which is well exhibited in some true *Naviculæ.* The very variable cell-contents of *Cocconema lanceolatum* and *Cymbella gastroides* are well illustrated. In *Encyonema gracile*, the author has detected and drawn some very peculiar moniliform corpuscles (possibly parasites) with a trembling motion in the middle of the frustules.

"Aphaneri"—Examination of Water.*—The water of the Lago Maggiore, which it has been proposed to convey to Milan, has lately been examined by Prof. Maggi by M. Certes' method,† the samples being taken at 65 m. depth, and about 400 m. from the banks. Forty-eight hours after a little osmic acid was added, there was obtained a small deposit of dead organisms of bacterian form, none of which had appeared in the Microscope. He found a solution of chloride of palladium to have also the effect of hardening these small organisms and so making them opaque and microscopically visible. Small irregular masses of protoplasmic nature, capable of taking colour from a magenta solution, were also thrown down. Prof. Maggi further treated the water of the lake with various colouring agents. Hæmatoxylin, methyl-violet, magenta, and Lione blue, gave the best results. While the same small organisms and protoplasmic masses were manifested, only the latter, curiously, took the colour. In spring water of Valcuvia, and rain-water, microbes like those in the lake, not visible with a power of 800 diameters, were revealed by the colouring and hardening reagents.

Prof. Maggi proposes to call these organisms *Aphaneri*, as distinguished from the bacteria and microbes which, without reagents, are visible in the Microscope (*Phaneri*), and among which are agents of infection, and which take colour from methyl-violet, magenta, &c. The Aphaneri, he thinks, are probably harmless.

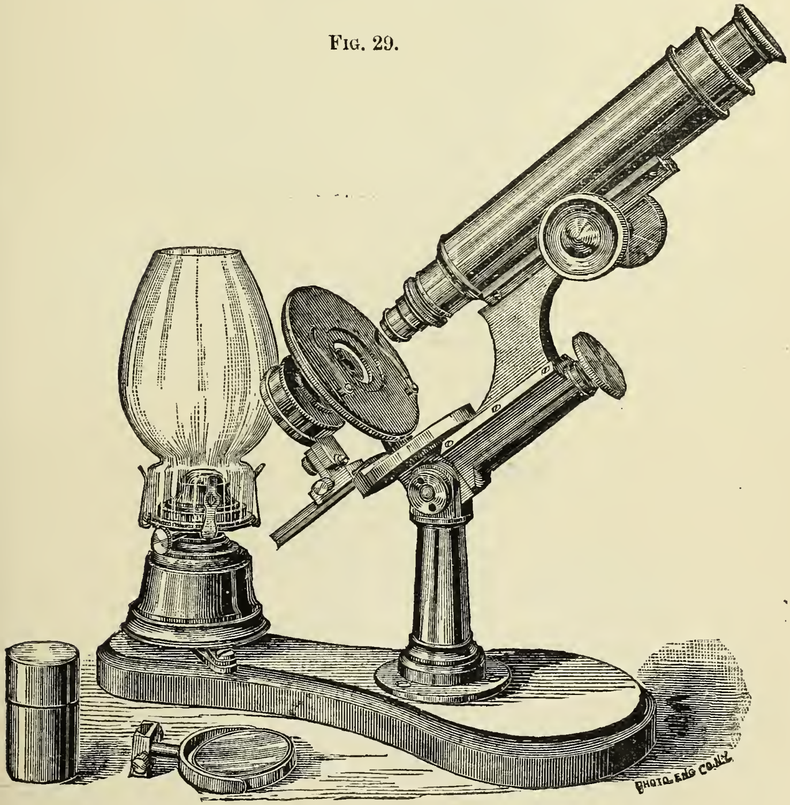
* Nature, xxv. (1882) p. 348.
† See this Journal, iii. (1880) p. 847.

MICROSCOPY.

a. Instruments, Accessories, &c.

"Acme" Class Microscope.—The "Acme" Microscope of Messrs. Sidle and Co. (described in Vol. III. (1880) p. 523) is now adapted for being readily converted into a Class Microscope (Fig. 29). This

Fig. 29.

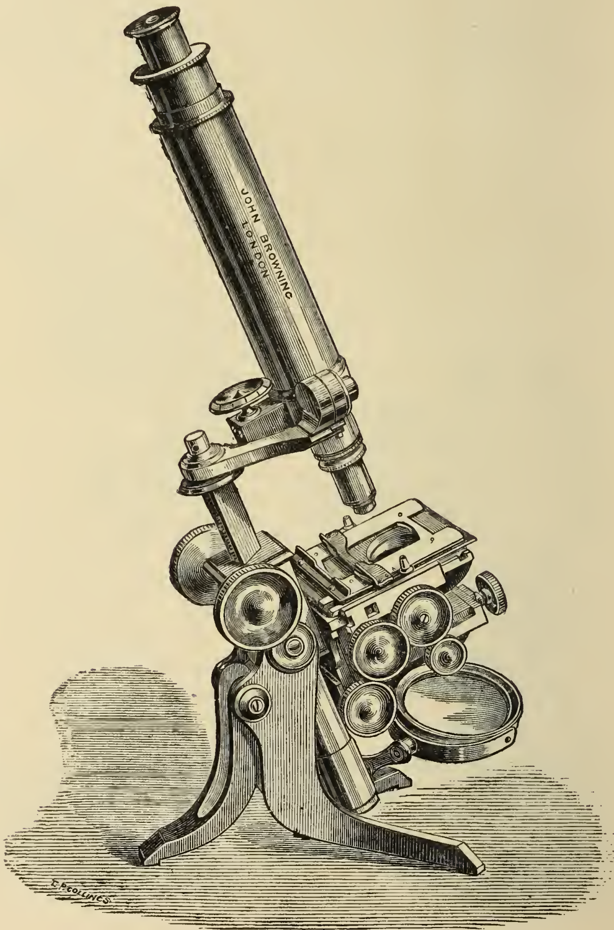


is accomplished by removing the metal tripod foot, and substituting for it a wooden base of suitable form, carrying upon a jointed arm a small lamp. It can then be handed round the class or lecture-room.

We think the ready conversion of ordinary students' stands into class Microscopes, is a point deserving the attention of opticians.

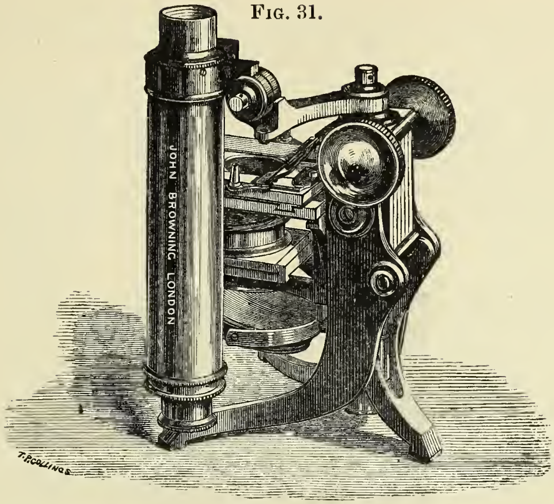
Browning's Portable Microscope.—This Microscope as set up for use is shown in Fig. 30. The stage has the usual rectangular motions, and there is also a substage. The speciality of the instru-

Fig. 30.



ment is that the body-tube turns on a joint as shown in Fig. 31, and that the posterior foot *b* of the tripod can be closed up between the anterior ones. The whole instrument will then pack into a case $6 \times 6 \times 9$ inches.

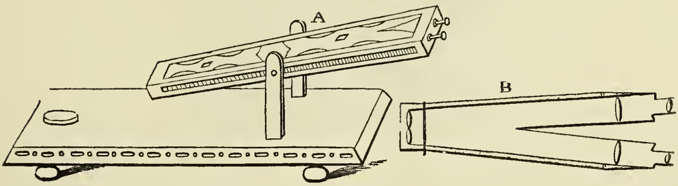
FIG. 31.



Harting's Binocular Microscope. — Professor P. Harting has suggested * a mode of making a binocular Microscope which has not hitherto been described.

The earliest binocular Microscope was that of Cherubin, 1678,† who simply combined two complete Microscopes in one frame (Fig. 32 ‡). Such a device could obviously only be made available with the lower

FIG. 32.



powers; with high powers the necessary proximity of the object would prevent the possibility of any joint convergence of the two objectives.

To obviate this difficulty Professor Harting placed two identical lenses side by side (A and B, Fig. 33) with their axes at an angle $m\ o\ n$ with one another. If the object $a\ b$ is at a distance equal to twice their focal length, two images of it will then be formed $a'\ b'$

* Das Mikroskop, 1859, p. 180.

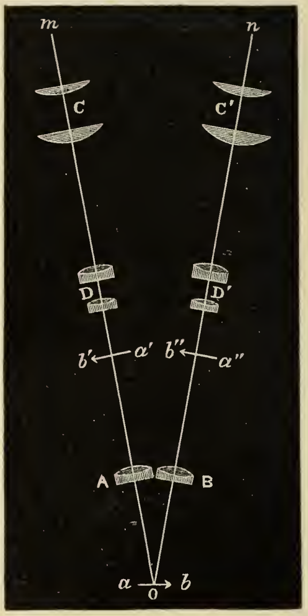
† 'De visione perfecta, sive de amborum visionis axium concursu in eodem objecti puncto.' Paris, 1678, pp. 77–100.

‡ This figure has been correctly copied by the engraver, but the eye-pieces in A would appear to be too narrow.

and $a'' b''$, each of which will be of the same size as the object. Two compound Microscopes with eye-pieces C and C′, and objectives D and D′, are then used to examine the two images.

Professor Harting writing in 1858 said "were the images $a' b'$ and $a'' b''$ so clear and sharp that they might be assumed to represent the object itself, objectives of short focal length might be used. But we are yet far from having the objects so represented by our present lenses. Even if the images are formed by objectives of fairly low power—1 to 2 cm.—the difference between the images and the

FIG. 33.



object is still too great, as was found as the result of some experiments made for the purpose. This contrivance cannot therefore be applied successfully to the construction of binocular Microscopes, which is the more to be regretted as this arrangement seems to satisfy better than any other the requirements of true stereoscopic vision. Perhaps future improvements in the construction of objectives will more readily allow of the accomplishment of the desired aim."

As this was written nearly thirty years ago, it is very probable that the defects in the objectives which were then found to mar the action of the suggested instrument would not now be met with, but we doubt nevertheless if it would be found at all worth while to construct such an instrument. Any improvement in the stereoscopic effect over

that furnished by some of the modern binoculars would be likely to be more than balanced by the additional complication of the instrument.

Nachet's Double-bodied Microscope-tube.*—An ordinary Microscope can be readily converted into one for two observers by the plan shown in Figs. 34 and 35. A nose-piece screws into the end of the

FIG. 34.

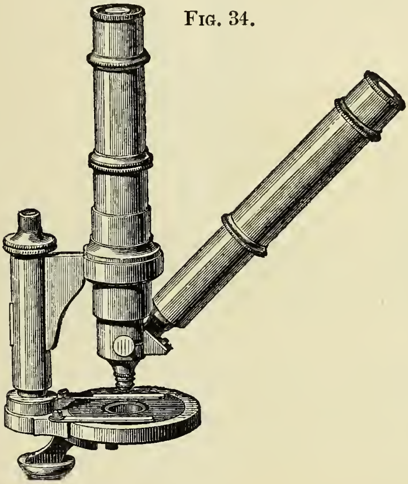
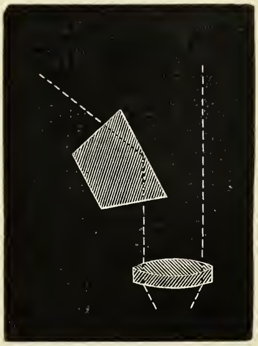


FIG. 35.



body-tube, carrying just above the objective a truncated prism, which bisects the pencil from the objective, allowing half to pass direct to the eye-piece, while the other is diverted by the prism into a second tube screwing into the nose-piece and set obliquely. Powers of 200 to 300 times can be used.

Wenham's Universal Inclining and Rotating Microscope.—This new Microscope (Plate IV.) has been devised by Mr. Wenham for the special purpose of obtaining a large range of effects of oblique light both in altitude and azimuth.

The principal movements are as follows: (1) an inclination of the limb together with the body-tube, stage, substage, and mirror, in a sector sliding within jaws attached to the rotating base-plate. The centre of this inclining motion is (very approximately) the point where the plane of the object cuts the optic axis, i. e. a point situated about the thickness of an ordinary object-slide above the centre of the surface of the stage; (2) a lateral inclination of the limb to either side upon an axis attached to the centre of the sector. The centre line of this axis prolonged forwards also intersects the optic axis in the plane of the object on the stage; (3) a rotation of

* See Robin, C., 'Traité du Microscope,' &c., 1877, pp. 72–3 (2 figs.).

the instrument upon its circular base, the optic axis being the centre of motion.

The leading principle followed in the construction of the stand is

Fig. 36.

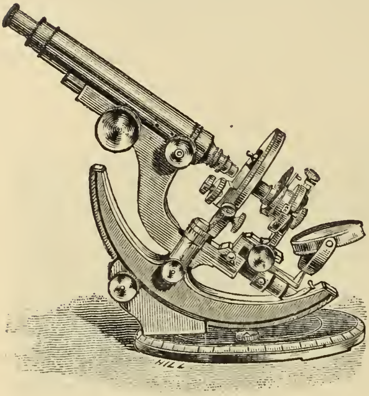
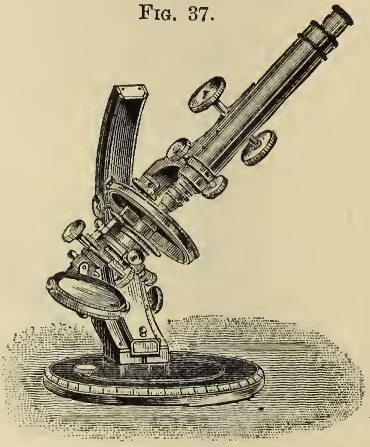


Fig. 37.



that when it is inclined backwards (as in Fig. 36), or turned laterally (as in Figs. 37, 38, and 39), or rotated on the base-plate, a pencil of

Fig. 38.

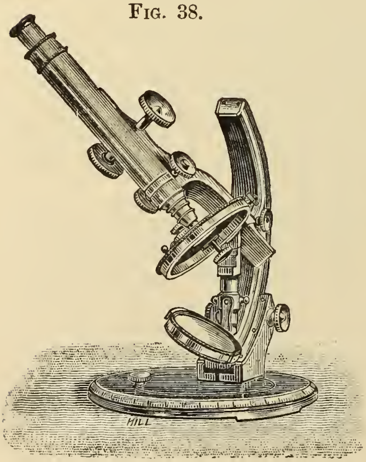
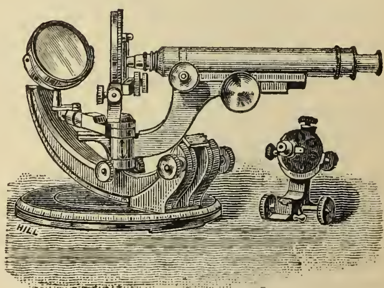


Fig. 39.



light from a fixed source will always reach the object, all the movements, whether separate or combined, radiating from the object (or the prolongation of its axes) as a centre.

The stage rotates completely and is a modification of Mr. Tolles's, in which the rectangular motions are effected by milled

heads acting on the surface and entirely within the circumference.* It is mounted on the Zentmayer system, and graduated near the edge, "finders" being engraved in convenient positions; two centering screws are provided by which exact rotation round the optic axis can be secured; and it can be easily removed, or may be replaced by a glass or metal friction-stage, &c. A simple and effective plan has been adopted of applying the iris-diaphragm, hemispherical immersion illuminator, or Wenham's "half-disk" illuminator, beneath the stage, where they are held by a small projecting peg and a spring latchet.

The substage can be removed entirely from the lower part of the limb by means of a metal dove-tail slide The usual rectangular (centering) and rotating motions are provided.

The substage condenser is furnished with a centering cap and a rotating plate of the usual series of slots, central stops, &c., an iris-diaphragm immediately beneath modifies the diameter of the circular opening utilized.

The coarse adjustment is of the usual "Jackson" form by means of a spiral pinion and diagonal rack-work.

The fine adjustment acts directly upon a vertical slide carrying the objective only, and is controlled by vertical milled heads on both sides of the nose-piece.

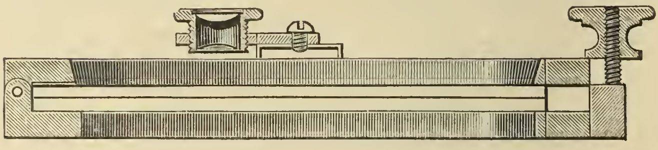
In illustration of the variety of motions obtained with this Microscope, Fig. 36 shows the sector inclined at about the usual position for working with central illumination; Fig. 37 shows the lateral inclination of the limb, &c., the sector being at its highest position; Fig. 38 shows the Zentmayer swinging tail-piece clamped to the sector (as suggested by Mr. J. Mayall, jun.), the limb being inclined laterally, and the substage removed. This lateral inclination of the limb causes the stage to revolve upon a central horizontal axis, so as to present the object to the illuminating pencil at all obliquities; Fig. 39 shows the sector at the lowest point so that the microscope-body is horizontal, the tail-piece being clamped to the sector, the limb swung laterally about 45° (to the right), and the substage removed. This position of the sector would be that required for measuring angles of aperture by means of the graduations on the circular base. The axis of the lateral inclining motion is also graduated, so that either the degree of inclination of the limb or that of the swinging tail-piece can be registered. In all these positions, and indeed in every position in which the various movements enable it to be placed, the Microscope is very steady.

The construction of the stand has been carried out by Messrs. Ross under Mr. Wenham's instructions, and we understand that they purpose making such modifications as will permit a lamp to be carried by the swinging tail-piece, or placed at the lower end of the sector; and the mirror to be attached at pleasure to a rotating slide in the centre of the base: these additions will add still more to the facilities for obtaining obliquely incident light.

* See the descriptions of similar stages, this Journal, i. (1881) pp. 116–117 (Figs. 9 and 10), p. 300 (Fig. 46), and pp. 944–6 (Figs. 221–3).

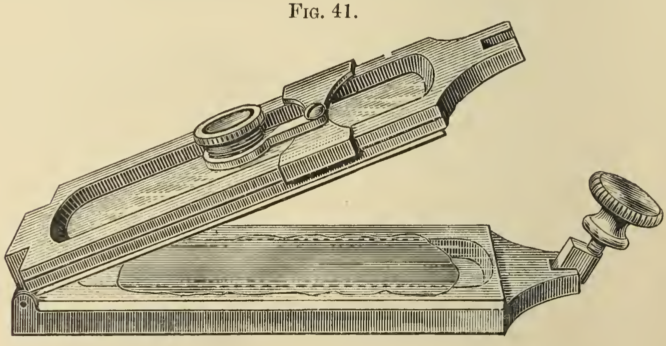
Bausch and Lomb Optical Co.'s Trichinoscope.*—Figs. 40 and 41 show the Trichinoscope recently issued by the Bausch and Lomb Optical Co. It consists of two metal plates, each pierced with a central hole and hinged together at one end, and so arranged that they can be forced together by the screw at the opposite end. Two glass plates

Fig. 40.



are inserted between them. A simple Microscope can be moved in different directions across the apertures in the plates so as to command a view of every part. It is focussed by being screwed up and down in the socket at the end of the arm which carries it.

Fig. 41.



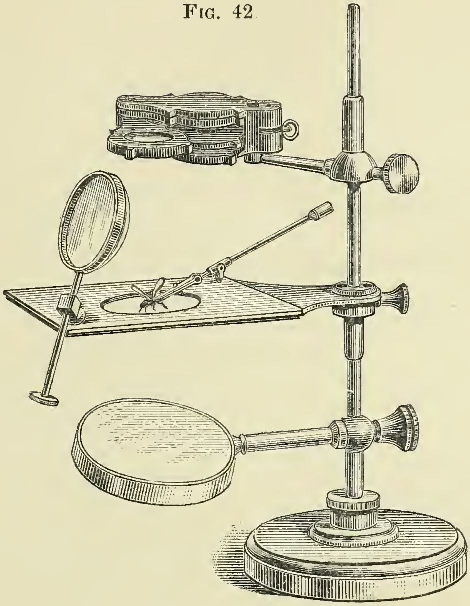
A thin slice of flesh having been moistened with a mixture of equal parts of acetic acid and glycerine, is put on the lower glass plate and spread out by needles or a brush, the second plate is brought down upon the lower one and the screw is placed in the slot into which it fits. By turning the screw any degree of pressure may be brought to bear on the flesh, which may thus be rendered so thin and transparent that any trichinæ present will be readily visible when the Trichinoscope is held up between the eye and light.

"Hampden" Portable Simple Microscope.—This instrument (Figs. 42 and 43) is made by Messrs. Beck and is the device of the wife of a distinguished English statesman now ruling in India. It combines, with great portability, very convenient arrangements for the

* Amer. Jour. Micr., vi. (1881) pp. 183–5 (3 figs.).

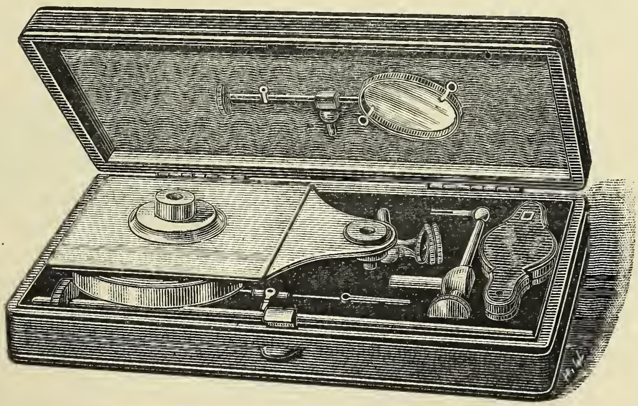
most effective use of a dissecting lens or simple Microscope in the field or when travelling.

Fig. 42.



The lens, stage, and mirror are each carried by a bar sliding on the upright stem which screws into the circular foot. The bars can be

Fig. 43.



adjusted to any height and secured by the screws, of which the milled heads are shown on the right of Fig. 42. When detached the instru-

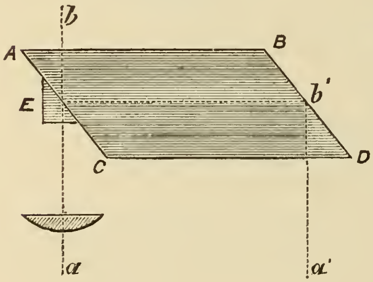
ment packs very conveniently into a small case $5\frac{1}{2}$ in. × $2\frac{3}{4}$ in. × $1\frac{1}{4}$ in. in the manner shown in Fig. 43, and is then readily carried in the pocket.

Sir John Lubbock, who has on several botanical excursions taken the instrument with him, speaks highly of its usefulness.

Excluding Extraneous Light from the Microscope.*—In order to exclude light of an injurious character, whether falling laterally on the eye of the observer or on the stage from above, T. W. Engelmann places the Microscope in a dark box, made portable, and admitting the light through a funnel-shaped opening in the broad front side. The body of the observer as well as the Microscope and its belongings are intended to be included in the box, which is 75 cm. high, 80 cm. broad, and 40 cm. deep, and is arranged so as to carry accessory apparatus, reagents, coloured glass plates, &c.

Nachet's Improved Camera Lucida.—In its original form this camera lucida consisted of a rhomboidal prism A B C D, placed over the eye-piece of the Microscope, as shown in Fig. 44, and having cemented to the face A C a segment of a small glass cylinder E, the ray *a b* from the eye-piece and that (a' b') from the pencil meeting the eye at *b*.

Fig. 44.



The disadvantage of this form was that the eye must be held very steadily just over the glass cylinder E (the function of which was to allow the rays from the object to pass to the eye-piece without refraction), to obviate which M. Nachet has made use of a suggestion of Professor G. Govi, and deposits a thin film of gold on the face A C of the prism (Fig. 45). The gold reflects the ray a' b' to *b* as

Fig. 45.

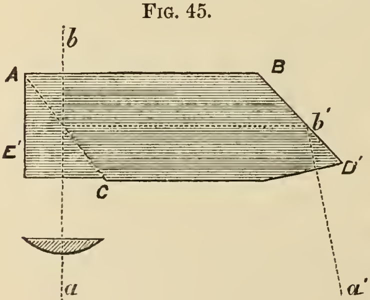
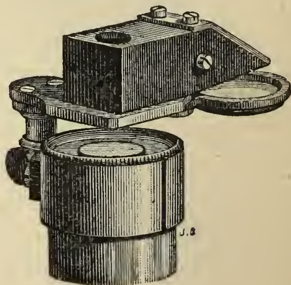


Fig. 46.



before; whilst, at the same time, on account of its translucency, it allows the ray *a* to pass through it from the eye-piece. The small

* Pflüger's Archiv ges. Physiol., xxiii. (1880) p. 571.

prism E is replaced by a larger one, E′, cemented upon the gold film (protecting it also from being rubbed off), and a slight inclination is given to the under surface at D′, in order to avoid too great an approximation of the pencil to the foot of the Microscope.

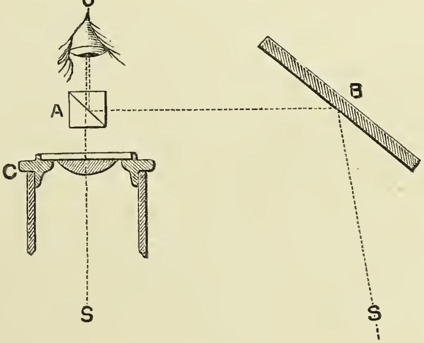
The image of the paper is tinted yellow by the rays reflected from the surface of the gold, while that of the object is of an emerald green tint, that being the colour given to the rays in passing through gold.

Fig. 46 shows the camera lucida in place over the eye-piece.

Abbe's Camera Lucida.*—Dr. L. Dippel commends the following as an extremely simple and complete apparatus for drawing on a horizontal surface.

A small glass cube A (Fig. 47) composed of two right-angled prisms cemented together is placed over the eye-piece C, one of the prisms having an hypothenuse surface silvered, leaving, however, a

FIG. 47.



circular hole. The cube is so adjusted that the hole exactly coincides with the "eye-point" of a Zeiss No. 2 ocular (C). The mirror B is connected with the fastening of A by an arm about 70 mm. from the axis of the Microscope.

In use, the instrument is fastened to the eye-piece cover by two centering screws, and the mirror so turned that the surface of the table close beside the foot of the Microscope appears to be projected on the circular field of the eye-piece. The whole field of view is now readily seen, and with uniform sharpness, and this is the case also when the higher powers are used, no perceptible loss of light taking place in the vision of the microscopical image. One of the most essential qualities of a good camera lucida is therefore obtained.

That the camera is attached to a particular eye-piece, and is not, as usual, made adjustable for those of different power, arises from the fact that in the higher Huyghenian eye-pieces the eye-point lies too near the eye-lens.

* Bot. Centralbl., ix. (1882) pp. 242–3 (1 fig.).

Dr. Dippel says that he has thoroughly tested the camera with very delicate drawings, and has found it of excellent service, and he considers it is to be preferred over all those forms for drawing on a horizontal surface in which the microscopical image is seen after several reflections, and the pencil direct.

Curtis's Camera Lucida Drawing Arrangement.*—Mr. Bulloch's new "Congress" stand has an arrangement for drawing, suggested by Dr. L. Curtis, "which is designed to do away with some of the difficulties attending the use of the ordinary camera lucida. A little table is fastened to the limb by milled-head screws; paper is placed upon this for drawing. One of Hartnack's right-angled camera lucidas is used. Drawing can be done in any position of the Microscope. There is hardly more preparation required for this than would be required to change an eye-piece. The comfort of this arrangement, when one is doing work which requires much drawing while observation is going on, needs to be experienced to be appreciated."

Drawing on Gelatine with the Camera Lucida.†—M. Créteur uses a metallic point for drawing objects with a camera lucida, the drawing being made not on paper, but on a sheet of gelatine laid on a dark ground. The shining point is always visible, and is claimed to provide a remedy for the indistinctness of the point of the pencil, which is the chief difficulty experienced in drawing with the camera by the ordinary method. The drawing can also be readily transferred to stone.

It is questionable whether the advantage gained through the greater distinctness of the drawing-point is not more than counterbalanced by the disadvantage of not being able to draw on paper. As the particular benefit claimed appears to rest upon the shining point, that could be obtained without great difficulty with an ordinary pencil.

Iris-Diaphragm for varying the Aperture of Objectives.—In 1869, Dr. Royston-Pigott applied an Iris-diaphragm behind the objective for reducing the aperture of objectives, in support of the view which he was then advocating that wide-aperture objectives produced confused images.

The editor of the 'Northern Microscopist' has recently suggested the use of such a diaphragm to enable penetration to be obtained with wide-angled objectives of different apertures. Fig. 48 is a side view of the apparatus, as made by Mr. C. Collins, and Fig. 49 a front view. The upper end in the former figure screws into the microscope-tube, while the lower receives the objective. The diaphragm is opened or shut by sliding the lever projecting at the side. The partial closing of the diaphragm does not, of course, contract the *field*, but diminishes its brightness by obstructing the passage of a greater or less part of the cone of rays.

* Amer. Mon. Micr. Journ., iii. (1882) p. 13.
† Bull. Acad. R. Méd. Belg., 1880, p. 617.

In some remarks on the use of the apparatus it is pointed out * that it shows the value of wide apertures for good definition, for if a preparation of the proboscis of the blow-fly be observed with an inch objective having an air angle of 30°, the view is superb, the pseudo-tracheal markings come out well-defined and sharp; but close the shutter until an angle of 14° or less is obtained, and examine again,

FIG. 48.

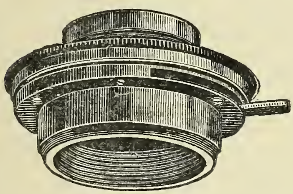
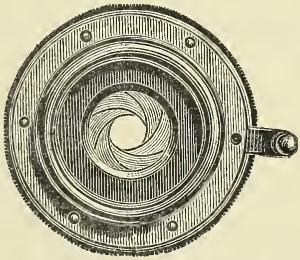


FIG. 49.



when it will be found that the definition is not nearly so good, while there is more penetration, the whole of the pseudo-tracheal tube being observed under one focussing. While in this condition, the eye being still applied to the tube, open the shutter to its full extent, and the effect of wide aperture will demonstrate itself.

"Perhaps the best object to show the amount of penetration possessed by objectives of low angle, may be found in the micro-fungus, *Myxotrichum deflexum*, or *M. chartarum*, observed under the 1-inch objective. The former object consists of little patches of grey downy balls, from which arise a number of radiating threads, furnished with a few opposite and deflexed branches. Under an inch objective of 30° air angle, but few of these branches can be seen under one focussing, the remainder being enveloped in a haze of light; but if a central layer be focussed, the simple closing of the shutter will suffice to bring the superior and inferior layers into view, though, of course, the image is not so bright and well defined as before."

Gundlach $\frac{1}{2}$-inch Objective †—Dr. L. Curtis recently exhibited to the State Microscopical Society of Illinois a new $\frac{1}{2}$-inch objective made by Gundlach, and claimed by the maker to have an angle of 100°. The back lens is large, and extends beyond the border of the opening in the screw. This opening, therefore, acts as a diaphragm. In order to secure the benefit of the full aperture, the portion of the objective can be removed, and an adapter furnished with the Butterfield broad gauge screw can be substituted. It has also another screw of about the same diameter as the Butterfield screw, but provided with a finer thread. The name and description of this screw were not known. The front of the objective is ground down to a conical

* North. Microscopist, ii. (1882) pp. 13–14 (2 figs.).
† Science, iii. (1882) pp. 19–20.

shape. For ordinary use this front is covered with a brass cap, having an aperture in the centre to allow the conical end of the objective to pass through. The cap can be removed when it is desired to use the objective for the examination of opaque objects. On removal of the cap the conical sides of the lens are seen to be covered with some sort of black varnish to prevent the passage of outside light. A Lieberkuhn is furnished, which can be screwed on in place of the cap while examining opaque objects.

Scratching the Front Lenses of Homogeneous-immersion Objectives.—It was recently objected to homogeneous-immersion objectives that the necessity of wiping the oil from the front lens after each observation was fatal to their utility as in time the front surface would thus become so scratched as to render the objective unfit for use.

This objection, however, overlooks the fact that even assuming it was really impossible to properly clear off the immersion fluid without "scratching" the lens, such scratches would not interfere with the use of the objectives. As the fluid used for immersion is *homogeneous*, that is, may practically be considered fluid crown glass, the scratches are optically obliterated as soon as they are in contact with the oil or other medium; in fact, it will be seen on reference to the original paper of Mr. Stephenson on homogeneous-immersion objectives,* that one advantage of the system was pointed out to be that in petrographical work the very imperfect polishing of thin sections of minerals, which had previously been a source of difficulty, was overcome by the approximately optical identity of the object and immersion fluid.

Fluids for Homogeneous Immersion.†—Dr. H. van Heurck, Director of the Antwerp Botanical Gardens, has undertaken an extended investigation of fluids suitable for homogeneous immersion, which (1) should have an index of 1·510–1·520 (line F), and (2) a dispersive power of 0·006 (between D and F), (3) should not be too fluid, and (4) should not attack the varnish of the slides.

Amongst the chemical solutions hitherto suggested, Dr. van Heurck mentions Bassett's fluid (which attacks varnish), chloride of cadmium in glycerine, iodide of zinc in glycerine, sulpho-carbolate of zinc in glycerine, and distilled chloride of zinc (difficult to use and not capable of being well preserved). Of the vegetable substances, cedar oil and oil of copaiba are referred to. The first is a product not of the cedar, but of *Juniperus virginiana*, and is much too fluid, and attacks the varnish of the cells. The second (distilled from different species of *Dipterocarpus*) is a little less fluid and therefore better.

To remedy the inconvenience of the extreme fluidity of cedar-oil, dammar has been dissolved in it, by which also its index may be raised to 1·54. Professor Abbe has recently suggested to the author that an excellent fluid may be obtained by dissolving dammar until the index is 1·520, and then reducing it to 1·509 by the addition of castor-oil.

* See this Journal, i. (1878) p. 52.
† Bull. Soc. Belg. Micr., vii. (1881) pp. xxii.-xxxi.

In his examination of new fluids, Dr. van Heurck met with no sufficient success amongst chemical products, but of vegetable substances three were discovered which appear to be in every way suitable.

The first is a solution of the resinous gum known as *oliban* (from several species of *Boswellia* of East Africa) partially dissolved in cedar-oil. It gives a fairly thick lemon-yellow liquid of refractive index 1·510, and dispersive power 0·0077. To prepare the liquid, pieces of very pure oliban are powdered finely, and the powder, mixed with its own volume of cedar-oil, is heated in the water-bath in a glass beaker for 2–3 hours. It is then left till the next day, when the supernatant liquid is drawn off.

The resin (*élemi*) of Brazil, and the white oily *tacamaque* of Guibourt give equally good solutions with oil of cedar. By dissolving the tacamaque in the oil a liquid is obtained with a refractive index of 1·519, and dispersive power of ·0074. By adding castor-oil to the solution in suitable quantity the index is lowered to 1·508, and the dispersive power to 0·0072. To prepare the solution, 20 parts by weight of the tacamaque are dissolved in the water-bath in 22 parts of cedar-oil and 14 parts of castor-oil added.

According to Professor Abbe, the latter solution and that of dammar in cedar-oil constitute the two best fluids for homogeneous-immersion objectives.

The third is copaiba of Maracaibo, derived from *Copaifera officinalis.* That found in commerce at Antwerp, and apparently authentic, had an index of 1·519, whilst a specimen from Guibourt of copaiba of Para was only 1·506. It dissolves readily in cedar-oil. Another liquid of 1·510 index and ·0076 dispersive power is obtained by dissolving 7 parts of light vaseline in 30 parts of copaiba. A very thick liquid results, not attacking varnish even after a contact of 24 hours. If it is found to be too thick it can be diluted by mixing with it a solution of copaiba in cedar-oil.

Other liquids from conifers were tried, but in all the dispersive power was found to be too high.

Dr. van Heurck fears that it will be very difficult to discover any substances which will satisfy microscopists who prefer *aqueous* liquids.

Advantage of Homogeneous Immersion.*—Dr. van Heurck also says that "the suggestion of Mr. Stephenson . . . . constitutes certainly the greatest advance which has been made in microscopy during late years. Personally we have been able to appreciate, better perhaps than any one, the importance of such objectives, for it is owing to them that the thousands of drawings in the 'Synopsis des Diatomées de Belgique' could be furnished in a relatively short time. When we think of the trouble that monochromatic illumination has caused us, and the frequent interruptions necessitated by the absence of the sun, we cannot sufficiently congratulate ourselves upon this fortunate discovery, which has enabled us to advance, by a good many

* Loc. cit., pp. xxii.–iii.

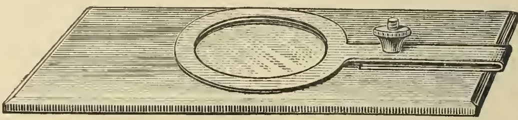
years perhaps, the publication of our work, all the drawings of which have been made or perfected by homogeneous-immersion objectives."

Vertical Illuminator for examining Histological Elements.*—Dr. E. van Ermengem commends the vertical illuminator for the illumination of such of the histological elements as can be mounted on the cover-glass dry. "Blood-corpuscles present an extraordinary appearance, their colour a lively red, their relief very appreciable, and the slightest inequalities on their surface clearly visible." Good results had also been obtained in the examination of semen, mucus, pus, and liquids containing bacteria, &c.; also of the minute structure of muscles and nerve-fibres.

Griffith's Parabolic Reflector.†—Mr. W. H. Tivy describes a method suggested to him by Mr. E. H. Griffith for utilizing a spoon for a "parabolic" reflector. Wind a clean copper wire of $\frac{1}{24}$ inch diameter closely round the base of an objective three times, twisting and bending the ends for a length sufficient to reach a little beyond the end of the objective. Cut a section of about half an inch from the bowl of a new plated teaspoon, and solder the convex side to the ends of the wire, also making the loop solid with solder, and filing it up to a good fit and figure, so that it will slip easily on and off the objective. The reflector is adjusted by bending the wire. "Thus I have a handy and useful piece of apparatus, at the cost of the spoon, 30 cents."

Forrest's Compressorium.—This compressorium (Fig. 50), designed by Mr. H. E. Forrest, is specially constructed with a view to cheapness. It consists of a strong glass (or if desired brass) plate,

Fig. 50.



3 inches by $1\frac{1}{4}$ inches, with ground edges. A small brass screw passes through the plate, the point projecting upwards through it about $\frac{3}{4}$ inch. A brass arm, bent so as to form a spring, rotates upon the screw as on a pivot, and carries at one end a brass ring holding a thin cover-glass, 1 inch in diameter, which covers the centre of the plate when in use. A milled nut works upon the screw above the arm, and when screwed down brings the cover-glass in contact with the glass plate. The spring acts upon and raises the cover, if the nut is unscrewed, so that the two glasses can be fixed at any degree of proximity required.

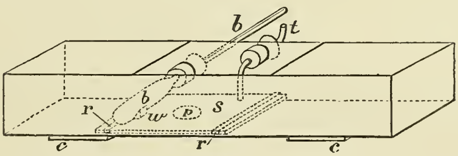
Julien's Stage Heating Apparatus.‡—In a paper on the examination of carbon dioxide in the fluid cavities of topaz, Mr. A. A. Julien thus describes the method employed in his investigations.

* Bull. Soc. Belg. Micr., vii. (1881) pp. xxxvii.–xl.
† Amer. Mon. Micr. Journ., ii. (1881) p. 238.
‡ Journ. Amer. Chem. Soc., iii. (1881) 12 pp. and 4 figs.

"The qualitative identification of carbon dioxide in the cavities of a mounted thin section of a mineral may be determined, at least with probability, after some experience, through various optical appearances and physical characteristics which have been often described. It is usually effected with certainty and ease, through the rapid and enormous expansion and ultimate disappearance, either of the liquid or of the gaseous bubble on the application of a gentle heat for a few seconds, such as that of a cigar, the heated end of a rod, or jet of hot air, or even a jet of the warm breath conveyed through a flexible rubber tube. When the slide and the section are thin, even the heat (37° C.) of the tip of one's finger applied for a few seconds to the bottom of the slide, without removal from the stage of the Microscope, may be sufficient to produce the characteristic phenomena, e. g. the contraction and disappearance of a bubble whose size is relatively small to that of the liquid in which it floats.

For the determination of the temperature of disappearance of the bubble, which may vary from 20° to 32° C., several forms of stage heating apparatus may be employed (those of Nachet, Beale, Fuess, Schultze, Chevalier, Dujardin, Ransom, Polaillon, Ranvier, and Vogelsang). In place of all these, a simple and inexpensive apparatus may be substituted, consisting of a miniature water-bath, in which are immersed the entire section and slide, the bulb of the thermometer, and the nose of the objective. It consists of a box of tinned copper (Fig. 51) (tinned iron is liable to rust), of length sufficient to project

FIG. 51.



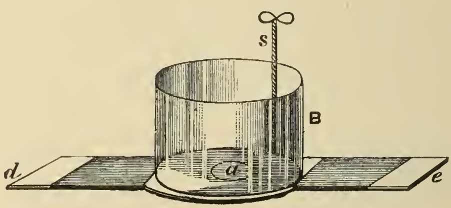
a few centimetres on either side of the stage of the Microscope employed; the one I use being 23 cm. in length, 4 cm. in width, and 3 cm. in depth. This is laid across the stage, separated from the metal by thin plates of cork *c c*, and is heated by a short wax taper (night-light) underneath either extremity. The slide *s* may rest upon the bottom, guarded from the metal by little rubber bands *r r* beneath its ends, and wedged firmly by a little wooden wedge *w* beneath the horizontal thermometer bulb *b*; or a thermometer with a ring-shaped bulb may be inserted, upon which the slide may rest directly, firmly attached by one or two slender rubber bands. The thermometer should be of guaranteed accuracy, with wide degrees, subdivided if possible, with a range which need not much exceed 20° to 32° C. The preparation is then covered by any pure and clear water, preferably filtered (distilled is unnecessary), to a depth of about 2 cm. A circular aperture in the bottom of the box, 18 mm. in diameter, is covered with glass attached by cement, and through this the light is thrown up from the mirror. The cavity to be examined is then care-

fully adjusted and focussed, a taper is lit, and the eye remains at the eye-piece until the critical point is reached. The glass tube *t*, with its point terminating just below the edge of the slide, is connected with the mouth during the experiment by a small rubber tube. As the temperature slowly rises, a constant current of small bubbles of the warm breath (whose temperature, 32°, only assists the operation) may be blown with little fatigue through the tube, to effect a thorough intermixture of unequally heated layers in the water stratum. The determination of the temperature of disappearance of the bubble is easily obtained within five minutes, and that of its reappearance in about the same time. A low-power objective may be carefully wiped if its anterior lens is dimmed by flying drops or rising vapour, when a high temperature is being attained; but it is best to insert the whole objective in a small, narrow glass beaker floating upon the surface of the bath over the preparation.

The apparatus, as thus constructed, may, the author thinks, be found the most convenient warm stage when high temperatures are required; but another still more simple, lately devised, will best serve for the determination of carbon dioxide, and consists of the following parts:—

First, a shallow glass tank (Fig. 52), with thin and well-annealed sides, of size sufficient to enclose the slide, upon which the thin

Fig. 52.



section is mounted. For this purpose I use a small chemical beaker B, with the thinnest bottom, and with its upper portion cut off, forming a thin round glass tank, about 6 cm. in diameter, and 3 cm. deep.

Secondly, a plate of copper or brass, like that used in Schultze's apparatus, or more simply one of the form represented in the figure *d e*. Its dimensions, proportioned to those of the beaker-tank and of the stage of a large Microscope, are as follows:—Length, 23 cm.; diameter at centre, 6·5 cm.; width of arms, 3·5 cm.; central aperture, 2·5 cm.; height of wire support, 13 cm.; thickness of plate, 1 mm. Each arm is wrapped in pasteboard, to prevent radiation, to the extent indicated by the shaded portion.

Thirdly, a delicate thermometer, with a small, short bulb bent at right angles to the stem, and a very fine column, to obtain sufficient sensitiveness to minute variations of temperature, and complete immersion of the bulb in the small volume of liquid employed in the bath. The scale need not exceed in range from about 20° to 32° C., the thermometer being of such length that when in position the scale from 27° to 30° C. may be on the level of the eye-piece of the Micro-

scope, and readily visible without motion of the head. Each degree of the column should be about a cm. in length, and subdivided to tenths.

Lastly, a pointed glass tube, with flexible rubber connection for blowing, and a wire support *s*, to receive both this and the thermometer, attached to the metal plate.

The latter is laid upon the stage of the Microscope, separated by thin plates of cork or a perforated piece of pasteboard; the tank, supplied with about 40 cc. of water, is placed over the central aperture *a*, and a taper beneath an extremity of one arm of the plate, and the apparatus is then ready for use in the way already described, the water of the tank being heated by conduction through the metal plate. The section of the mineral is best mounted upon a very thin slide, 45 mm. by 26 mm., and this is guarded as before with rubber bands, and held down by one or two little brass weights. Only a single taper is necessary for the low temperature required in the examination of carbon dioxide cavities, and even with this a temperature of 43° C. may be obtained in the bath within a few minutes. The disappearance of the bubble may be completed in less than five minutes, the taper being removed as soon as the rising column approaches within 2 or 3 degrees of the critical point, roughly determined by a previous trial. If two tapers are used, the temperature of the water may be raised to 55° in about 20 minutes, or even much higher, by the use of Bunsen gas burners. In summer the temperature of the atmosphere alone may be sufficient, especially if assisted merely by the current of warm breath, to obliterate the gas bubble. Its return may be readily caused, in a warm atmosphere, by adding from time to time a few drops of cool water to the bath, while the eye remains at the eye-piece, and a steady current of air is blown through the glass tube. Mounted slides used for such experiments must be labelled by writing with a diamond, or the paper label may be rendered waterproof by being coated successively with weak size and any transparent varnish, such as copal or shellac.

From these experiments it may be inferred that with this apparatus, which may be called the immersion warm bath, it matters little for most purposes what liquid, stand, or objective is employed; that water is preferable to glycerine, from its greater mobility, convenience, and lack of cost; that its bulk is immaterial, so long as the bulb of the thermometer is covered; that it is decidedly advantageous to immerse the anterior lens of every objective in the bath, to avoid the annoying interference with observation produced by the vibration of the surface, and by the necessity for repeated refocussing, when the objective is above the surface of the liquid; that careful determination on minute cavities, with high powers, carried on slowly to enable the preparation, objective, and thermometer to assume the same temperature, may be as accurate as any others; and that there is no difficulty in obtaining satisfactorily the two determinations within ten minutes to an approximation of about one-twentieth of a degree.

The descriptions of this method, and of these forms of apparatus, have been given in the more detail, inasmuch as they may be of

service in many other branches of thermal microscopy where the exact determination of the temperature applied is desirable, e. g. as suggested by Mr. A. H. Elliott, in the determination of the melting point of rare chemical substances, &c. For this purpose, the apparatus in Fig. 51 might be supplied with another tube, on the opposite side to those represented, through which might be inserted, beneath the objective, a small glass tube containing the substance to be examined, and thus immersed, by the side of the thermometer bulb, in the water, oil, paraffin, or other liquid which the circumstances may require for the bath."

Beck's Achromatic Condenser for Dry and Immersion Objectives.—In an earlier form of (dry) condenser (Fig. 53), Mr. Beck made use of a revolving front rotating a series of lenses mounted on a plane

Fig. 53.

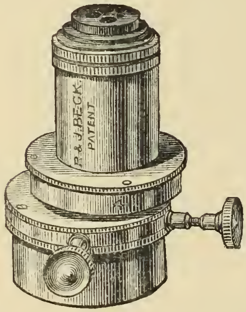
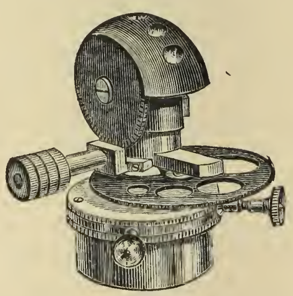


Fig. 54.



surface over the back combination. This plan was, however, only available for a dry condenser; if used for immersion, the connecting fluid would be drawn away by capillary attraction.

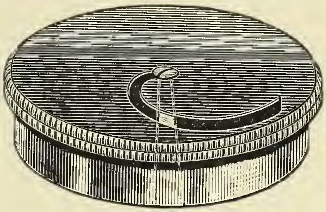
To avoid this inconvenience, the new form shown in Fig. 54 has been devised, the movable series of front lenses being mounted in a segment of a sphere and rotated by a milled head acting on a pinion and toothed disk. The first lens, when brought over the back combination, has a low angle, and is intended for use without fluid for histological objects. By revolving the diaphragm, the angle can be varied from 35° to 7°. The next is a full aperture lens with which, by revolving the diaphragm, the angle can be varied from 180° downwards. The third lens, with full aperture of diaphragm, has an angle of 110° in glass = 1·25 N.A., and is truncated, cutting out the central rays. The fourth lens has also an aperture of 1·25, and is truncated, so as to stop out all rays up to 180° in air. The fifth is similar to No. 3, but the periphery is painted over, so as to allow pencils only at right angles to pass.

Pennock's Oblique Diaphragm.*—Mr. E. Pennock suggests an adaptation of Mr. Mayall's spiral diaphragm,† to be attached to the

* Amer. Journ. Micr., vii. (1881) p. 161 (3 figs.).
† See this Journal, i. (1881) p. 126.

under side of the stage, for shutting off all light except a small pencil from the mirror. It may be mounted in either of two forms: the one to fit into the usual tube, which, in the cheaper Microscopes, is attached to the under side of the stage, the other to screw directly into the stage aperture.

Fig. 55.

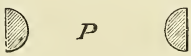


The device is shown in Fig. 55. The milled edge serves to rotate the plate with the spiral slot over the radial slot (shown by dotted lines), thus giving varying degrees of obliquity.

Stereoscopic Vision with Non-stereoscopic Binocular Arrangements.—It will be remembered that in his paper "On the Conditions of Orthoscopic and Pseudoscopic Effects in the Binocular Microscope,"* Professor Abbe pointed out that an orthoscopic (stereoscopic) effect was produced if the *inner* halves of the "Ramsden circles" just above the eye-pieces were shut off by diaphragms (that is like O, Fig. 56), and a pseudoscopic effect when the *outer* halves were so dealt with (that is like P, Fig. 57).

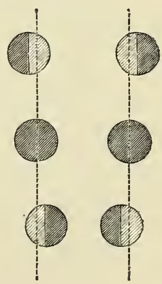
Fig. 56.

Fig. 57.



Dr. A. C. Mercer, of Syracuse, U.S.A., points out that this explanation solves a difficulty which has perplexed many microscopists, and has hitherto remained unexplained. Powell and Lealand's high-power binocular is essentially non-stereoscopic, and theoretically ought not to give any appearance of relief to the objects. It has nevertheless been frequently observed that a distinctly stereoscopic effect was obtained, and this was attributed entirely to the imagination of the observer. Dr. Mercer, however, shows that it is a true and not an illusory effect, and that it depends upon the extent to which the eye-pieces are separated.

Fig. 58.



When the eye-pieces are at such a distance apart that the Ramsden circles correspond exactly with the pupils of the eyes, centre to centre (Fig. 58), the object appears flat. If, however, they are racked down so as to be somewhat nearer together, the centres of the pupils fall upon the *outer* halves of the Ramsden circles, and we have the conditions for orthoscopic effect; while if they are racked up so as to be more separated the centres of the pupils fall on the *inner* halves and we have pseudoscopic effect.

This is quite in accordance with what takes place in the use of

* See this Journal, i. (1881) pp. 203–11 (3 figs.).

eye-pieces, the halves of which are actually covered with diaphragms, for when the inner halves are cut off the tubes naturally require to be racked down to diminish the separation of the eye-pieces, and in the converse case to be racked up; Dr. Mercer also satisfied himself by experiment as to the validity of his deductions by observing sugar pills pushed half-way through holes in black cards, the pills being marked with cross marks in pencil to increase the effect. They could be made to appear convex, concave, or flat, according to the position of separation of the draw-tubes.

We have, for simplicity, referred to the covering up of *both* halves of the eye-pieces, but it is not of course necessary to cover up more than *one*.*

In order to obtain the *best* stereoscopic effect the halves (or one of the halves) of the eye-pieces of the Powell and Lealand or other similar binocular arrangements should be actually shaded by diaphragms so as to aid in properly centering the pupils, but Dr. Mercer's object is to show that the effects observed with ordinary eye-pieces are explicable upon proper theoretical principles, and so to relieve those observers who have insisted upon the existence of true orthoscopic effects in such cases, from the reproach which has unjustifiably attached to them on account of their supposed abnormal and unscientific development of a power of drawing upon their imagination.

[The Bibliography for the period intervening between that contained in the Journal of October 1880 and the end of 1881, will be found in the Appendix to this volume.]

ABBE's Experiments on the Diffraction Theory of Microscopical Vision. [General remarks.]
Journ. of Sci., IV. (1882) pp. 118–9.

Acme Microscopes. *Amer. Natural.*, XVI. (1882) p. 261.

American Society of Microscopists.
[Review of Proceedings for 1881, and remarks on the meeting at Elmira for 1882.]
The Microscope, I. (1882) pp. 175–7.

Angular Aperture.
[Letter by 'Akakia,' describing Dr. Robinson's method of measurement.]
Engl. Mech., XXXIV. (1882) pp. 454–5.

BROWNELL, J. T.—A much-needed Stop.
[Suggestion for a "thumb-screw" to prevent Microscopes at Soirées being focussed too low to the injury of the slides.]
Amer. Mon. Micr. Journ., III. (1882) p. 39.

BULLOCH's New "Congress" Stand.
Amer. Mon. Micr. Journ., III. (1882) pp. 9–13 (2 figs.).

Carlisle Microscopical Society—Inaugural Address by the President, Canon Carr. *North. Microscopist*, II. (1882) pp. 17–19.

CARR, E.—*See* Carlisle.

Cheap Microscopes.
[Letter by C., advocating the encouragement of their purchase and display, and further discussion by Welborn, G., Ollard, J. A., Cooper, C. C., F., J., E. Holmes, A., E. C., and Medehanstade.]
Engl. Mech., XXXIV. (1882) pp. 470, 495–6, 520–1, 545.

COX, J. D.—Prof. Rogers' Micrometers.
Amer. Mon. Micr. Journ., III. (1882) pp. 23–5.

* See this Journal, i. (1881) p. 211, Fig. 38.

Crisp, F.—Notes sur l'Ouverture, la vision microscopique et la valeur des objectifs à immersion à grand angle. (Notes on Aperture, Microscopical Vision, and the value of wide-angled Immersion Objectives)—*contd.*
[Transl. of paper I. (1881) pp. 303–60.]
Journ. de Microgr., VI. (1882) pp. 44–8, 91–5 (13 figs.).

Curtis, L.—New ½-in. Gundlach Objective of 100°.
Amer. Mon. Micr. Journ., III. (1882) pp. 19–20.
The Microscope, I. (1882) pp. 194–5. *Science*, III. (1882) pp. 19–20.

Davis, G. E.—The limiting Diaphragm or Aperture Shutter.
North. Microscopist, II. (1882) pp. 13–14 (2 figs.) p. 75.
Amer. Mon. Micr. Journ., III. (1882) pp. 49–50.
Engl. Mech., XXXV. (1882) p. 25 (2 figs.).

„ „ A Visit to an Objective Factory.
[W. Wray's, Highgate.]
North. Microscopist, II. (1882) pp. 21–4.

Dippel, L.—Abbe's Camera Lucida.
Bot. Centralbl., IX. (1882) pp. 242–3 (1 fig.).

Forrest's (H. E.) Compressorium. *North. Microscopist*, II. (1882) p. 51.

Griffith, E. H.—The Griffith Cell. *Amer. Mon. Micr. Journ.*, III. (1882) p. 9.

Guillemin, A.—Le Monde Physique. Tome II. La Lumière. (The Physical World, Vol. II., Light.)
[Contains a Chapter on the Microscope (20 pp., 20 figs., and 3 coloured Plates), a section on Microscopical Photography (7 pp. and 5 figs.), and one on the Applications of Photography to the Arts and Physical and Natural Sciences, 4 pp. and 3 figs.]
8vo, Paris, 1882. 668 pp., 353 figs., and 26 plates.

Hitchcock, R.—Large and Small Microscopes.
[Rejoinder to C. Stodder.]
Amer. Mon. Micr. Journ., III. (1882) pp. 16–7.

„ „ The Microscopist.
[Further reply as to Stowell's 'The Microscope.']
Amer. Mon. Micr. Journ., III. (1882) pp. 18–9.

Holmes, E.—Drawing, &c., from the Microscope.
[Recommends Mr. Dallinger's plan of drawing on finely smoothed glass.]
Sci.-Gossip, 1882, p. 39.

Journal of the Royal Microscopical Society for 1881.
[Note on the small number of original contributions to the 'Transactions' and the reason for it.]
Journ. of Sci., IV. (1882) p. 56.

Microscopical Societies.
[Note as to an intended alteration in the printing of their Reports.]
Amer. Mon. Micr. Journ., III. (1882) pp. 14–5.

Miles, J. L. W.—Dark-field Illumination by the Bull's-eye Condenser.
[Placed beneath the stage, plane side uppermost, with a spot of black paper in the centre.]
North. Microscopist, II. (1882) p. 39.

„ „ Substitute for a Revolving Table.
[A piece of table oil-cloth, 15 in. sq., the cloth side turned to polished and the oil side to painted tables.]
North. Microscopist, II. (1882) pp. 39–40.

Nachet, C. S., Death of. *Journ. de Microgr.*, VI. (1882) pp. 3–4.

Objectives, Verification Department for.
[Tabular results of measurements of objectives.]
North. Microscopist, II. (1882) pp. 7, 24, 59.

Ollard, J. A.—Mr. Kitton's Illumination.
[Commending same, and recommending the use of distilled filtered water, filling the globe full to prevent a shaky light, and not using too much sulphur chlorate (first filtered).]
Sci.-Gossip, 1882, p. 47.

Pocklington, H.—The Microscope at Home.
Engl. Mech., XXXIV. (1882) pp. 538–9, 560–1.

PRINGSHEIM'S Photochemical Microscope.
Quart. Journ. Micr. Sci., XXII. (1882) p. 86.

S., H. C.—An "English Mechanic" Microscopic Club.
Engl. Mech., XXXIV. (1882) p. 615.

SALT'S and SWIFT-BROWN Microscopes.
Engl. Mech., XXXIV. (1882) p. 463 (3 figs.).

SCHRÖDER, H.—Ueber Projektions-Mikroskope. (On Projection Microscopes.)
Centr. Ztg. f. Optik u. Mech., III. (1882) pp. 2–4, 15–17 (1 fig.).

SHIPPERBOTTOM, W.—Improvements in Photo-micrography.
North. Microscopist, II. (1882) pp. 48–9 (2 figs.) p. 75.

" " Use of the 'Aperture-shutter' in Photo-micrography.
North. Microscopist, II. (1882) p. 75.

Slow motion for Micro. Stand.
[Letter by 'Sunlight,' describing the ordinary form used with the 'Jackson Model.']
Engl. Mech., XXXIV. (1882) p. 457 (1 fig.).

STALLYBRASS, H. M.—Microscopic Illumination.
[Approval of F. Kitton's Hollow Glass Sphere Method, I. (1881) pp. 112-3—by adding a few drops of pure sulphuric acid, cloudiness of the liquid is prevented.]
Sci.-Gossip, 1882, p. 64.

STODDER, C.—Large vs. Small Stands.
[Reply to R. Hitchcock's Criticism.]
Amer. Mon. Micr. Journ., III. (1882) pp. 13–4.

SUFFOLK, W. T.—On Microscopical Drawing. *Sci.-Gossip*, 1882, pp. 49-50.

TISSANDIER.—Microscopic Photography in Paris.
[Abstr. of article from 'La Nature.']
Engl. Mech., XXXIV. (1882) p. 561.

β. Collecting, Mounting and Examining Objects, &c.

Injection of Invertebrate Animals.*—G. Joseph uses filtered white of egg, diluted with 1 to 5 per cent. of carmine solution, for cold injections. This mass remains liquid when cold; it coagulates when immersed in dilute nitric, chromic or osmic acids, remains transparent, and is sufficiently indifferent to reagents. A mass of similar properties is made of glue liquid when cold, coloured with the violet extract of logwood reduced with alum. Injection is effected in the case of worms (leech and earthworm), by way of the ventral or dorsal vessel, with large Crustacea by the heart or the ventral vessel which lies in the sternal canal.

In many cases, especially when lacunar spaces have to be filled, useful preparations are obtained by natural injection (*auto-injection*, or *autoplerosia*). Natural injection of Medusæ is effected without injuring the vessels; in the case of Crustacea, Insects, and Mollusca, through a slit with an opening at the side remote from it. Medusæ are laid in a glass vessel, with the bell downwards, and a bell-jar ending in a narrow tube above is placed over it and made air-tight; after the Medusa is covered with the injection-mass, the air in the glass is exhausted, and the sea-water running out by slits in the lower side of the annular canal the coloured fluid runs in.

* Ber. naturw. sect. Schles. Ges., 1879, pp. 36–40. Cf. Zool. Jahresber. Neapel for 1880, i. pp. 45–6.

In the case of leeches and large species of earthworms, the natural injection is made from the ventral sinus. In all cases a glass tube is used, with a finely drawn-out point. The injection is complete when the injection issues from the counter-opening.

Animals to be injected alive are kept quiet by cold (laying upon ice). Besides the animals mentioned, large caterpillars, beetles, Libellulid larvæ, locusts, &c., have served as objects for injection; the glass cannula is introduced into the posterior end of the dorsal vessel, and the counter-opening is made in the ventral vessel, and *vice versâ*.

Cold Injection Mass.*—A. Wikszemski describes a modification of Pansch's method:—Thirty parts by weight of flour and one of vermilion are mixed while dry, and then added to 15 parts by weight of glycerine and subjected to a continuous stirring until of a homogeneous viscous consistency; then 2 parts of carbolic acid (dissolved in a little spirit) are added to it, and finally 30 to 40 parts of water. This injection mass is specially adapted for subjects already injected with carbolic acid (in the proportion of $1\frac{1}{2}$ part by weight each of carbolic acid, spirit, and glycerine to 20 of water); 24 hours are allowed to elapse between the two injections. It is a good thing to introduce a little dilute injection first.

Staining with Saffranin.†—According to W. Pfitzner, staining with saffranin is most successful with chromic acid preparations which have been entirely freed from the acid, less so with substances hardened in picric acid; the only tissues suited to it are those which very readily take up colour, and these must be cut extremely thin. The sections are transferred to the staining fluid (1 part saffranin, 100 absolute alcohol, 200 distilled water) from distilled water, are again placed in distilled water after a few seconds, and then into absolute alcohol, from which they are removed at the right moment (i. e. when the nuclei are properly stained) to dammar varnish. The advantage of staining with saffranin is that it affects the nuclei exclusively. Dr. M. Flesch ‡ remarks that the advantage claimed by Pfitzner for saffranin has been shown by Hermann to be shared with it by other aniline dyes when applied in the same manner.

Staining with Silver Nitrate.—Staining with nitrate of silver is very difficult to effect in the case of marine organisms, owing to the abundance in which chlorides occur in them. R. Hertwig § meets this difficulty by washing the animals (after hardening in osmic acid) with distilled water until the water used for washing gives but a very slight precipitate with solution of silver nitrate, and then allowing a 1 per cent. solution of the nitrate to act for 6 minutes.

* Arch. f. Anat. u. Entwick., 1880, pp. 232–4.

† Morph. Jahrbuch, vi. (1880) p. 469. Cf. Zool. Jahresber. Neapel for 1880, i. p. 43.

‡ Ibid., pp. 43–4.

§ Jen. Zeitschr., xiv. (1880) p. 324.

C. Golgi,* in studying the peripheral and central nervous fibres of the spinal cord, exposes the nerves to the action of osmic acid, chromic salts, and silver nitrate, according to certain methods of combination. For example, a nerve is removed with care from a freshly killed animal (rabbit), and placed in a mixture of 10 parts of a 2 per cent. solution of potassium bichromate with 2 parts of 1 per cent. osmic acid solution. After about an hour the nerve is divided into smaller pieces of ½ to 1 cm. in length, and again placed in the solution, where it is left some hours longer (it must be examined every 3 hours), and finally is placed for not less than 8 hours in 0·5 per cent. solution of nitrate of silver, and then mounted in dammar varnish in the ordinary way. Better preparations are produced by placing nerves which have been exposed—in the case of peripheral nerves 8 hours, of central nerves 10 to 15 days—to the action of bichromate of potash, then from 12 to 24 hours to silver nitrate, and mounted in dammar varnish without previous exposure to the light.

Staining Tissues treated with Osmic Acid.—Damaschino, in a communication † to the Société de Biologie, advocates osmic acid in the form of a solution of 1 per cent. for human spinal cord divided into lengths of 1 cm., and for the spinal cord of smaller animals treated entire; he afterwards hardens in absolute alcohol. If it is then not sufficiently hard, the preparation is saturated with gum before being placed in the alcohol; the sections, which are penetrated with gum, are transferred unstained to Canada balsam without being previously freed of gum by means of water.

Referring to this communication (which contains no really new point), L. Malassez ‡ remarks on the difficulty of staining substances which have been treated with osmic acid, and for this reason he first stains the sections with other staining matters, and then exposes them to the action of osmic acid, and this in such a way as to allow only the vapour of the solution of acid to act. He claims to have obtained admirable results by this method, since in this way all the properties of the osmic acid come into play without affecting the other staining substances.

R. Hertwig § placed the animals (Ctenophora) examined by him in a 0·05 per cent. solution of osmic acid, to which in some cases he added acetic acid solution of 0·2 per cent. for from 5 to 15 minutes, according as he wished to investigate the epithelium or the elements of the gelatinous tissue; he then stained with carmine and finally preserved in dilute glycerine.

Mounting the "Saw" of the Tenthredinidæ.‖—Mr. P. Cameron describes his method of mounting and preserving the "saw" of the Tenthredinidæ for microscopical examination, a method which can be applied to microscopical mounting generally.

* Arch. per le Sci. Med., iv. (1880) pp. 221–46 (1 pl.). Cf. Zool. Jahresber. Neapel for 1880, i. p. 44.

† Gazette medic. Ann., li. (1880) p. 636. ‡ Ibid., p. 637.

§ Jenaisch. Zeitschr., xiv. (1880) p. 315. Cf. Zool. Jahresber. Neapel for 1880, i. p. 41.

‖ Trans. Entomol. Soc. Lond. 1881, pp. 576–7.

With fresh specimens the saws can be extracted by pressing the abdomen, when they will be protruded and readily extracted. With old specimens it can be done equally well by placing the insect in a relaxing-dish, or, more promptly, by steeping it in water for a day, when they can be taken out in the same way as with fresh insects, the only difficulty being experienced with insects full of eggs. For their better examination the four pieces composing the ovipositor proper should be separated ; after which they must be steeped in turpentine for a day or two so as to get rid of air. This is be-t done by enclosing them in a small folded piece of paper; and, if they be properly labelled, many different preparations can be placed in the turpentine-bottle together.

Next take a sheet of fine Bristol board, and cut it up into pieces, say 12 lines × 9 lines, and punch at one end a round or square hole, four or five lines across. On the lower side of this fasten, by means of Canada balsam dissolved in benzine, a cover-glass. When this has dried fill up half the cell thus formed with the same composition, spreading it as evenly as possible, and in it arrange your preparation. Put it aside for some hours in a place where no dust will fall on it, then fill the cell with enough balsam to run over the edge of the cell, place a cover-glass over it, and press it down. All that now requires to be done is to allow the preparation to dry, taking special care to keep it flat, to label it, and stick a pin through the card, by means of which it is fixed in the cabinet alongside the insect from which the part was taken. To examine it under the Microscope, all that is necessary to do is to place an ordinary glass slide across the stage, and put the card on it, in doing which it is not necessary to take the pin out of it if a short pin be used.

The great advantage of this plan for entomological purposes is that it does not necessitate the formation of two distinct collections, which must be the case if dissections are mounted on glass slides, which cannot of course be placed alongside the insects. Besides that, it is cheaper, more expeditious, and safer ; for the cards are so light that no injury comes to them from falling, or getting loose in the box. If desired, a coloured ring can be put round the top object-glass by the turntable in the ordinary way, but except for ornament, is not necessary. The author usually prepares two or three dozen of the cards with one cover-glass on at a time, so as to have them ready for use. The object of letting the dissections harden in the cell, half filled with balsam, is that three or four separate parts may be arranged in the most suitable way in the same cell without fear of their being disarranged or injured when the top cover-glass is put on, while both might happen if the whole operation was performed at once.

For the examination of the saws, a quarter-inch objective is the best, the teeth, in some cases, are so fine that they are apt to be overlooked if lower powers are used.

Mounting Butterfly-scales.*—Dr. D. H. Briggs recommends the following process. Dissolve 1 part of Anthony's "French Diamond

* Amer. Mon. Micr. Journ., ii. (1881) p. 227.

varnish" in 2 parts of pure benzole. Apply a drop or two of the solution to a slide, and in a few seconds, or as soon as the varnish has set, press the wing of the butterfly gently upon the slide, and then carefully lift it away. The scales will be found transferred to the slide in their beautiful natural arrangement * on the wing. Make a shallow cell around the mounting and apply the cover-glass. Canada balsam must not be used, as it disarranges the object.

Imbedding Ctenophora.†—For imbedding Ctenophora (for the most part after hardening in osmic acid), R. Hertwig employs gum-glycerine very largely diluted with water; it is allowed to remain in contact with the air, with the substance to be cut immersed in it, until it has acquired the consistency of a stiff syrup. Shrinkage of the gelatinous tissue is to some extent obviated by this plan, owing to the slowness with which it absorbs the constantly thickening gum-glycerine.

Staining Living Protoplasm with Bismarck Brown.‡—L. F. Henneguy having treated *Paramœcium aurelia* with an aqueous solution of aniline brown (known in commerce as "Bismarck brown"), was surprised to see them assume a rather intense yellow brown colour, and move rapidly about in the fluid. The colour first appeared in the vacuoles of the protoplasm, and then it invaded the protoplasm itself. The nucleus generally remains colourless, and thus becomes more visible than in the normal state. Infusoria thus coloured were kept for nearly fifteen days. If a yellow-tinted *Paramœcium* is wounded or compressed so as to cause a small quantity of the protoplasm to exude, it is seen that it is really the protoplasmic substance which is coloured. All Infusoria may be equally stained with Bismarck brown, but no other aniline colours employed by the author exhibited the same property, they only stained the Infusoria after death, and some of them are in fact poisonous.

As it is generally admitted that living protoplasm does not absorb colouring matters, and that Infusoria are essentially composed of protoplasm, M. Henneguy endeavoured to ascertain whether protoplasm in general, of animal or vegetable origin, behaved in the same way in the presence of aniline brown.

A tolerably strong dose of Bismarck brown was injected under the skin of the back of several frogs. After some hours, the tissues were uniformly tinted a deep yellow, the muscular substance especially had a very marked yellow tint. The frogs did not appear in the least incommoded.

Small fry of trout placed in a solution stained rapidly and continued to swim about.

Finally, a guinea pig, under whose skin some powder of Bismarck brown had been introduced, soon presented a yellow staining of the buccal and anal mucous membranes and of the skin.

Seeds of cress sown on cotton soaked with a concentrated solution

* It should be observed that the scales will have their under sides uppermost, which is not the "natural arrangement."—Ed.

† Jen. Zeitschr., xiv. (1880) pp. 313–14.

‡ Rev. Internat. Sci. Biol., viii. (1881) pp. 71–2.

of the Bismarck brown sprouted, and the young plants were strongly stained brown; but on crushing the tissues and examining them under the Microscope it was ascertained that the protoplasm of the cells was very feebly coloured; the vessels on the contrary showed a very deep brown staining up to their termination in the leaves.

The mycelium of a mould which had been developed in a solution of Bismarck brown, was clearly stained after having been washed in water, whilst it is known that the mycelium which frequently forms in coloured solutions, picrocarmine, hæmatoxylin, &c., remains perfectly colourless.

Other aniline colours injected under the skin of frogs stained the fundamental substance of the connective tissue as deeply as did the Bismarck brown; but the cells of the muscular substance remained perfectly colourless.

The author concludes therefore that Bismarck brown possesses the property of colouring living protoplasm both in plants and animals.

Preservation of Infusoria and other Microscopical Organisms.*—A. Certes, in a note supplementary to his previous communications,† says that five years' experience has only confirmed his view of the efficacy of osmic acid and iodized serum for preparing Infusoria; but sometimes, notwithstanding precautions, the animalcules become black and opaque from a too prolonged action of the osmic acid; or, especially when iodized serum or lemon juice has been employed as a fixing reagent, mouldiness attacks the preparations either because the bottles have been badly corked or precautions for excluding germs from the preparations have been neglected.

It will be found however that ammonia ($\frac{1}{3}$) will clear preparations blackened by osmic acid, and thus the always dangerous use of cyanide of potassium will be avoided; but it is necessary to watch the operation with care, the time of immersion in ammonia being essentially variable according to the thickness of the animalcules and the quantity of osmic acid in excess.

With regard to mouldiness, it is possible, with certain precautions, to filter the liquid which holds the altered gatherings in suspension, upon pure glycerine. To increase the hardening of the animalcules, the liquid in excess is first removed and replaced by strong alcohol, by picrocarmine, or by green picrate of methyl, it is then poured gently on the glycerine, which, owing to its density, remains at the bottom of the vessel, but previously the liquid to be filtered must be briskly agitated so as to disengage the animalcules caught by their cilia in the matted fibres of the moulds.

The Infusoria thus detached fall first to the bottom. The patches of mycelium which offer more surface and consequently more resistance do not sink, or sink much more slowly. Advantage is taken of this circumstance to decant the liquid with a pipette, and to collect from the bottom of the vessel the Infusoria which, being isolated, are best adapted for observation.

* Bull. Soc. Zool. France, vi. (1881) pp. 36–37.
† See this Journal, ii. (1879) p. 331; iii. (1880) p. 847.

In default of osmic acid, filtered lemon juice may be employed; but it is necessary to follow the operation closely in order to check at the right moment the action of the reagent, which should be employed in a strong dose, and which consequently would in the long run injure the extremely delicate tissues of the Infusoria.

Impregnation by chloride of gold is generally successful after the action of lemon juice. Often, however, the pulverulent deposit gets entangled in the cilia of the Infusoria and obscures observation. Filtration upon glycerine reduces this inconvenience.

In conclusion, M. Certes indicates the process which he considers best for preserving the intestines of Batrachians with the object of examining the parasites they enclose. Having tied the intestine at the two extremities, it is washed in distilled water and placed in a solution of osmic acid (1–1000). After twenty-four hours' immersion, this solution is replaced by strong alcohol or by glycerinated water. Under these conditions, Opalinæ and other inhabitants of the rectum of Batrachians may be kept undistorted till they can be examined.

In a subsequent paper,* the author mentions that he has met with difficulties in the latter process. When the walls of the intestine are too thick or are too much filled by food, there is so great an absorption of the reagent that the Opalinæ and other parasitic Infusoria are dissolved under the action of the liquids of the organism or by the preservative liquids. He thinks it will be found sufficient to increase the strength of the osmic acid solution, and to slit the intestine longitudinally.

Staining the Nucleus of Infusoria.†—A. Certes has already shown ‡ the property possessed by cyanin or chinolin blue (and Bismarck brown) of staining living tissues, the nucleus of Infusoria not, however, appearing to be coloured either during life or even several hours after death. Dr. Henneguy having pointed out to him the analogous properties of a methyl violet, known as dahlia, M. Certes has repeated his experiments with several violets, and has found that, notwithstanding their very similar chemical composition, their action varies considerably. Some are always toxic, and for all species of Infusoria. Others only stain certain species out of those living in the same liquid. Others—and this is the special object of his further communication—stain the nucleus of living Infusoria, and more strongly than the rest of the protoplasm. In general with the violets in question, the cilia are always stained, and the liquid of the contractile vacuole often participates (so far as could be judged) in the general colouring.

The phenomena of selection of the colouring matter in regard to the nucleus was clearly established, at first with B B B B B violet on *Balantidium* from the intestine of *Bombinetor igneus*, and then on *Paramecium*, *Vorticella*, &c., with the same and dahlia violet. Gentian

* Bull. Soc. Zool. France, vi. (1881) p. 228.
† Ibid., pp. 226–7.
‡ See this Journal, i. (1881) pp. 527, 694.

and 50 N violet on the contrary, notwithstanding their great colouring power, did not exhibit any selective action with the nuclei.

As to the greater or less resistance which very closely allied species oppose to the action of the same reagent, the author mentions that he has found small species of *Paramecium* continue to live indefinitely without staining, whilst all the others of equal or greater size had entirely disappeared from the same liquid.

The staining of the nucleus of the Infusoria is, the author (erroneously) says, " a new fact, and it is so much the more interesting to note that the most recent researches demonstrate the preponderating part which the nucleus plays in the phenomena of nutrition and reproduction, and, if one may so say, in the government of the life of unicellular organisms."

Aniline Dyes and Vegetable Tissues.*—Mr. J. M. Macfarlane, in a paper on the action of some aniline dyes on vegetable tissues, records some of the more important methods arrived at.

" *Staining of Laticiferous Vessels.*—Every botanist must have experienced the difficulty of obtaining thoroughly good preparations of laticiferous vessels. Sachs recommends boiling in dilute potash; but, while tolerably good sections may be obtained in this way, several difficulties are encountered. The points to be aimed at in preparing this tissue are (*a*) the coagulation of the latex, so that it may continue to fill the vessels; (*b*) the staining of the cut sections, so that the vessels may be distinctly differentiated from the surrounding cellular substance; (*c*) the successful mounting of these, so that the tint may be permanently retained. The first part of the process is best accomplished by obtaining, for example, a large and entire root of *Scorzonera*, so that extensive bleeding may be prevented. A suitable sized bottle being filled with alcohol, pieces of the root from one to two inches in length are cut and immediately placed in it. Coagulation of the latex is quickly effected. After lying thus for a week or longer, sections are cut with the hand, or by aid of a microtome. The second point is most important, and on its success the beauty of the object will depend. The sections are placed in alcoholic solution of saffranine, obtained by dissolving 1 part of this dye in 800 parts spirit. After 18 to 24 hours, they are removed from the stain and decolorized by washing repeatedly in spirit. It will be found that the stain leaves the cellular tissues rapidly, while it is retained by the latex in the vessels. We will notice, lastly, the best method for mounting these. While such media as balsam or dammar would cause unnatural contraction, fluids, on the other hand—especially acetic acid solution—are apt to act slightly on the dye. I have found nothing to equal glycerine jelly, as it preserves the tint and is easily worked.

Double Staining of Stems, &c.—The dyes usually recommended for this purpose are rosaniline and iodine green; but saffranine and emeraldine are preferable, as the former is, for vegetable tissues, a

* Trans. Bot. Soc. Edin., xiv. (1881) pp. 190–1.

most permanent dye, while the latter imparts a brighter colour than iodine green.

Staining of Cell Contents.—While some aniline dyes act specially on the thickened walls of cells, others are extremely useful for demonstrating the structure of protoplasm. Heliocin and naphthaline in this respect are valuable; and eosin, though not an aniline dye, is equally so. For epidermis cells and ordinary parenchyma the latter is preferable. It is best prepared by dissolving 1 part in 1200 of alcohol. The specimens are allowed to lie for 5 minutes in the stain, and are then washed in water and mounted in a cell with acetic acid, or Goadby's solution. The cells of *Spirogyra*, however, have their minute structure beautifully revealed by treatment with heliocin. The following is the best method to adopt:—Decolorize the filaments by placing them in a 1 per cent. solution of chromic acid for two days; add then to the solution 1 part in 2000 of the dye, and shake slightly, so that it may dissolve equally. In an hour the filaments will be ready for examination or permanent preparation."

Indol as a reagent for Lignified Cell-membrane.*—Max Niggl gives a *résumé* of the observations of previous observers on the use of indol as a reagent for testing the lignified condition of the cell-wall, supplemented with additional observations of his own.

If a section of a branch is treated with dilute hydrochloric acid, and an alcoholic solution of indol added, the lignified cells acquire a beautiful cherry-red colour, while the non-lignified cells of the cambium, cortex, and epidermis remain uncoloured. The use of hydrochloric acid is, however, for several reasons inconvenient, and the author prefers the use of dilute sulphuric acid of sp. gr. 1·2 (1 vol. English sulphuric acid with 4 vols. water). The best mode of procedure is as follows:—Pure indol is dissolved in warm water. The section is moistened with a drop of this solution, and covered with a cover-glass. The indol is then removed by blotting-paper, and a drop or two of the dilute sulphuric acid run in. Wherever this comes into contact with the indol which permeates the section, the lignified cell-walls take a beautiful cherry-red, the sclerenchymatous cells even a purple colour, which is retained by the preparation for a considerable time. If the acid used is too concentrated, or the excess not removed, the colour passes, after some weeks, to brownish red.

Among Thallophytes, Niggl found, by the use of this reagent, no trace of lignification in algæ, or in the majority of fungi; it was only present in the cortical and medullary layers of a few lichens.

In vascular plants the cuticle is as a rule uncoloured by indol. In many plants (contrary to the statement of other observers), the walls of the guard-cells of stomata appear to be strongly coloured. This is also the case with cork, except that in older cork-cells the middle lamella gives indications of lignification. With very few exceptions collenchyma also shows no colouring with indol. The author enters into considerable detail with regard to the colouring of the various elements of parenchyma, and of sclerenchyma. A charac-

* Flora, lxiv. (1881) pp. 545–59, 561–8.

teristic property of tracheids is the very early and strong development of lignification in their cell-walls. In the walls and disks of sieve-plates, on the contrary, indol produces not the least reaction.

Protoplasm acquires a slight rose-colour with indol and sulphuric acid, but no differentiation of the nucleus is observable; the contents of the stinging hairs of the nettle assume throughout a red colour. No effect is produced on the contents of resin-passages.

The author concludes that the red colour imparted by indol and sulphuric acid is an unfailing test for the lignification of the cell-wall.

English's Method of Preserving Hymenomycetes and Wild Flowers.*—When we mention that the price of this book is 7*s.* 6*d.*, and that each of the two sections only contains as much matter as two columns of the *Times*, it will be obvious that it cannot be abstracted without seriously interfering with its proprietor's expected profits. We therefore confine ourselves to generalities.

For Fungi, a double preservative compound is used, formed of British farina, methylated spirit and corrosive sublimate, oxalic acid and sulphur. There is also an "adjunct to the process," formed of plaster of Paris and sulphur, for imbedding the specimens after the preservative has been applied. The final process consists of varnishing. Waxing and colouring can also be adopted if desired, for which directions are given.

The process for flowers (which has only been tried for two years) is to imbed them in plaster and lime as an absorbent, and gradually heat them up to 100° F. After dusting, they are varnished with similar varnish to that used for Fungi.

Mounting Salicine Crystals.†—Dr. D. H. Briggs recommends the following process:—

Clean the slide perfectly with ammonia, then rinse with hot water and cleanse with ammonia again.

Add to the salicine from one-tenth to one-twentieth its weight of pulverized gum arabic. Make a nearly saturated solution of the salicine and gum in distilled water, or in ice-water heated to the boiling point, and carefully filter the solution. Heat the solution to 100° C. in the beaker, and pour the hot solution upon a still hotter (*sic*) slide, and drain off. Only a hot solution will give bright colours.

Hold the slide, and watch for disks of crystals. As soon as these appear, place the slide on a cold iron block.

A rim is put on the crystals by another heating over the lamp and another cooling on the iron. Without delay heat a drop of Canada balsam on a circular cover-glass, and apply the cover to the crystals, and fasten with white zinc cement on a turntable.

The process described, if followed with care, will yield most

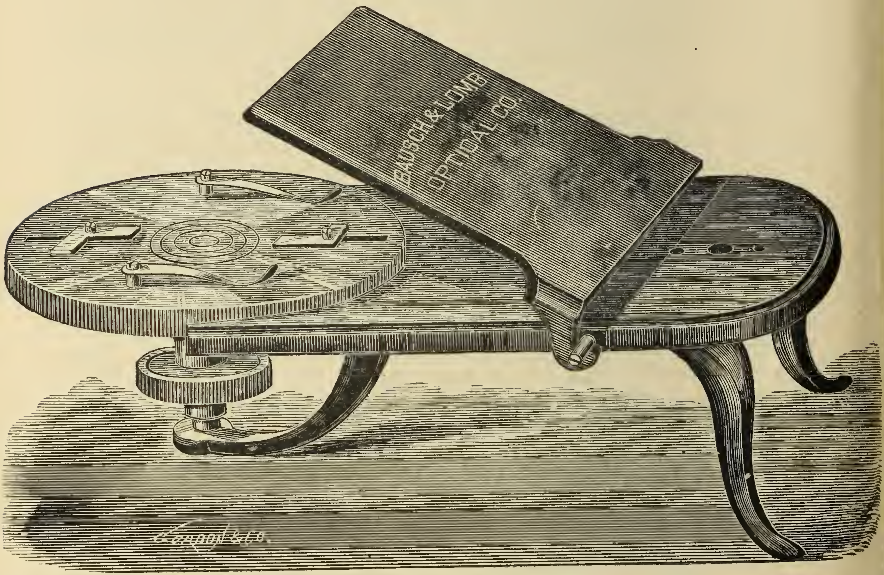
* English, J. L., 'A Manual for the Preservation of the Larger Fungi (Hymenomycetes) in their natural condition, by a new and approved Method; also a new Process for the Preservation of Wild Flowers.' viii. and 41 pp. 8vo. Epping, 1882.

† Amer. Mon. Micr. Journ., ii. (1881) pp. 227–8.

excellent results; perfect rosettes of crystals can be readily obtained, giving brilliant effects with polarized light.

Bausch and Lomb Turntable.—We have no description of this turntable, but so far as we can gather from the drawing (Fig. 59), it

Fig. 59.



differs from other turntables in being provided with a hand rest, which can be adjusted to any convenient height.

Griffith Cell.*—Mr. E. H. Griffith places the slide on a turntable, and with white-zinc cement turns a circle on the centre if for a transparent mount, or a disk if for an opaque one, then centres to the circle or to the disk a common curtain ring, and immediately paints the ring with the cement, taking care not to push it from its position. When dry, the cement will hold the ring very firmly, so that there need be no fear that it will break off.

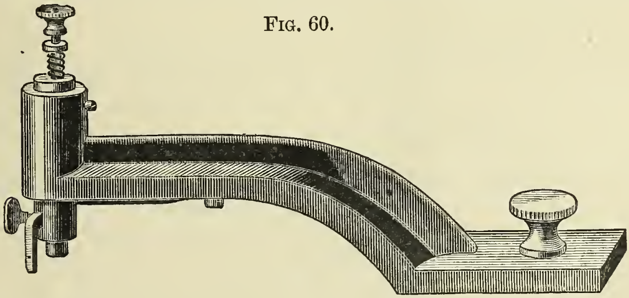
If a shallow cell is desired the rings may be flattened easily; or if a deep one is required, several rings may be securely fastened one above the other by painting each one in succession. If the cement does not flow readily add benzole; and in case the cell becomes rough, dip the brush in clear benzole and smooth it. Use a brush well filled with the cement to secure a smooth background. With a little practice a person may easily make fifty beautiful and practical white cells in one evening, and in a few hours they will be hard and ready for use. When the cover-glass is to be fastened, a little of the

* Amer. Mon. Micr. Journ., iii. (1882) p. 9.

cement is easily applied. When dry, the slide may be finished with colours prepared from tube paints mixed with benzole balsam, or with dammar and benzole. Before mounting, if a dark background is desired, a disk of asphalt of any desired size turned in the centre of the ring will be found convenient. Over the asphalt a small-sized cover-glass may be used for the object to be placed upon, or the asphalt may be covered with shellac when dry. The object may be fastened with gelatine or gum arabic, or made to adhere to the coat of shellac before it becomes dry.

Bausch and Lomb Circle Cutter.*—This instrument for cutting circles of thin glass (Fig. 60) is intended to be attached to the turntable, by means of the screw shown at the right of the figure, so

FIG. 60.



that the cutting point stands over the turning plate. The thin glass is placed upon the turntable and held by the central pin which then revolves with the glass. A gentle pressure causes the cutting point to touch the glass, and perfect circles can thus be readily obtained.

Wax and Guttapercha in Dry Mounting.†—Prof. W. A. Rogers, of Harvard College Observatory, writes:—"Notwithstanding the general condemnation of wax as a cement for covers in dry mountings, it is doubtful whether the objections urged against its use are altogether valid. I have had rather more than my share of experience in unsuccessful mountings of this class. During the past five or six years, I have been engaged upon the problem of the exact subdivision of any given unit into equal parts. Whatever success I may have gained in this direction has, I suspect, been somewhat more than counterbalanced by the deterioration of the ruled plates through the condensations which have formed under the covers.

"I have lately collected quite a large number of these plates for the purpose of studying the characteristic defects of different kinds of mountings. As the result of this study, I have reached the conclusion that, for the most part, the primary cause of the condensations which form under the covers, is the moisture remaining upon the glass after the operation of mounting. No matter how thoroughly a glass slide

* Amer. Mon. Micr. Journ., ii. (1881) pp. 225–6 (1 fig.).
† Ibid., p. 190.

may be rubbed, if it is immediately held over a flame, a certain amount of moisture will appear.*

"The evaporation from certain kinds of cement, without doubt aggravates the difficulty, and probably this is, in some cases, the independent cause of 'sweating.'

"Nearly all of the slides examined were prepared in the following way: First, the cover-glass being held in position upon the slide by a clip, the moisture was expelled by heating. After the glass had become sufficiently cooled, small bits of white wax were placed around the edge of the cover-glass. The blunt point of a heated piece of metal was then passed slowly around the cover, and the melted wax flowed under it, far enough to hold it in position. The larger number of the slides prepared in this way were found to be well preserved. When, however, rings of cement were turned upon the slides, the protection was in almost every case less perfect. In every case in which shellac with anilin colouring was used, condensations on the under side of the cover-glass were found. The covers of several slides were removed, and in no case was there any sweating found upon the surface of the slide.

"About eighteen months ago, my attention was called to the use of sheet guttapercha rings for dry mounting. My first experience with these rings was not altogether satisfactory. It is now evident that I did not, at first, apply sufficient heat to expel all of the moisture between the cover and the slide.

"After an experience of several months, I am convinced that slides prepared in the following way, will remain in a perfect state of preservation for any length of time. Use guttapercha rings having a thickness of about one five-hundredth of an inch, and a diameter about one-twentieth of an inch less than that of the cover-glass. Hold the cover in position upon the ring with a light clip, while the guttapercha is being melted by a gentle heat. If too much heat is applied at first, the ring will lose its normal shape. After the gutta-percha is thoroughly melted, the slide should be heated sufficiently to expel every particle of moisture from under the cover. While the slide is hot apply white wax to the surface, the melted wax will run under the cover and will be stopped by the ring. After covering, the wax can be removed from the surface of the glass with turpentine.

"I shall esteem it a favour to be informed of any case in which a ruled plate, mounted in this way, has failed to remain in good condition."

Aeration of Aquaria.—Mr. J. W. Stephenson points out that it is impracticable to effectually aerate an aquarium in the way suggested by M. Künckel d'Herculais, *ante*, p. 131. The only really effectual method is to direct a very fine stream of water at a high velocity obliquely upon the surface of the aquarium at about the distance of an inch. By this means air in the finest possible state of subdivision is carried some distance below the surface with the result of ensuring a thorough aeration of the whole contents.

* But will not moisture always appear on glass placed over a candle or other flame, through water being formed by the union of hydrogen with the oxygen of the air?—Ed.

It was by this method that Mr. Stephenson was able to keep the water in his marine aquarium so pure that (in 1867) he hatched the spotted dog-fish and (in 1870) herring from the egg, which had not previously been accomplished. The former was hatched at the expiration of five months and nine days, and the latter of ten days, after the eggs were placed in the aquarium.

The object of M. Künckel d'Herculais was apparently to devise a means of aerating a *marine* aquarium by means of a fall of *fresh water*, but the extra quantity of sea-water required to aerate an aquarium in the way proposed by Mr. Stephenson is not likely to present any difficulty, as it is easy to devise a plan by which a constant circulation can be maintained between the reservoir and the aquarium, without loss of water taking place.

Reference may also be usefully made to an article by Mr. C. J. Watson on "a simple mode of aerating small marine aquaria," * in which he also describes a method of injecting air by the fall of a small quantity of fresh water.

Boyd, J.—How to Make Wax-cells.
[F. Barnard's method, III. (1880) p. 860–1.]
Sci.-Gossip, 1882, pp. 59–60.

Brittain, T.—Micro-fungi: when and where to find them.
North. Microscopist, II. (1882) pp. 15–16.

Bryan, G. H.—How to label Microscopic Slides.
[Instead of one thin paper label at one end, use two made of slips of thick card 1 in. by ½ to ¾ in.—they can then be placed one against the other without the glass of one slide touching the cover of the next, and hence there is no need of a cabinet, as any box of a suitable size will do.]
Sci.-Gossip, 1882, p. 64.

Crumbaugh, J. W.—Our Histological and Pathological Laboratories. II.
[Views as to what should constitute a good working laboratory.]
Amer. Mon. Micr. Journ., III. (1882) pp. 37–9.

Cunningham, K. M.—Cleaning Diatoms.
Amer. Mon. Micr. Journ., III. (1882) p. 14.

D., A. J.—Improvements in Turntables.
[Improvement by W. D. Smith in Kinné's self-centering turntable—explanation unintelligible.]
North. Microscopist, II. (1882) pp. 74–5.

Eger, L.—Der Naturalien-Sammler. Praktische Anleitung zum Sammeln, Präpariren, Conserviren organischer und unorganischer Naturkörper. (The Collecting Naturalist. Practical Guide to the Collection, Preparation, and Preservation of organic and inorganic Natural Objects.) 5th Ed. 8vo. Vienna, 1882, pp. iii. and 221. 37 figs.

English, J. L.—A Manual for the Preservation of the Larger Fungi (Hymenomycetes) in their natural condition, by a new and approved Method; also a new Process for the Preservation of Wild Flowers. viii. and 41 pp. 8vo. Epping, 1882.

Heurck, H. van.—Immersion Fluids.
[Transl. of paper in 'Bull. Soc. Belge Micr.' See Appendix.]
Amer. Mon. Micr. Journ., III. (1882) pp. 26–8.

Hey, W. C.—Pond-collecting in Mid-winter.
[Reports result of fishing some ponds near York on 2nd January.]
Sci.-Gossip, 1882, p. 31.

Laspeyres, H.—Ueber Stauroskope und Stauroskopische Methoden. (On Stauroscopes and Stauroscopic Methods.)
Zeitschr. f. Instrumentenk., II. (1882) pp. 14–24 (3 figs.).

* Midl. Natural., iii. (1880) p. 270.

Malbranche, A.—Réactifs pour l'étude des Lichens. (Reagents for the study of Lichens.) *Rev. Mycol.*, IV. (1882) pp. 9–10.

Microscopic Curiosity.
[Working steam-engine so small that a thimble will cover it.]
Amer. Mon. Micr. Journ., III. (1882) p. 19.

Mounting Class of Manchester Microscopical Society.
[Report of meeting.]
North. Microscopist, II. (1882) p. 40.

Niggl, M.—Das Indol ein Reagens auf verholzte Membranen. (Indol, a Reagent for Lignified Membranes.)
[Abstr. of original article in 'Flora,' LXIV. (1881) pp. 545–59, 61–6.]
Bot. Centralbl., IX. (1882) pp. 284–5.

Reinsch, H.—Detection of Boric Acid, Silica, and certain Metals by means of the Microscope. *Journ. Chem. Soc.*, XLII., Abstracts, (1882) p. 245, from *Ber. Deutsch. Chem. Soc.*, XIV. 2325–31.

S., W. J.—Mounting for Hot Countries.
[Inquiry for hints as to mounting in Canada Balsam and Dammar Varnish in India, and statement of difficulties experienced.]
Sci.-Gossip, 1882, pp. 39–40.

Semper, C.—Bemerkungen zu Herrn Dr. Riehm's Notiz "Eine neue Methode der Trockenpräparation." (Remarks on Dr. Riehm's note on "a new method of dry preparation.") *Zool. Anzeig.*, V. (1882) pp. 144–6.

Stocker, G.—Preserving Flowers. *Sci.-Gossip*, 1882, pp. 65–6.

Stowell, C. H.—Laboratory Notes (*contd.*).
[Examination of sputa in suspected cases of phthisis, &c.]
The Microscope, I. (1882) pp. 172–4 (1 fig.).

Vorce, C. M.—The Detection of Adulteration in Food. V. Red-pepper and Turmeric. VI. Butter.
Amer. Mon. Micr. Journ., III. (1882) pp. 1–6 (1 pl.) pp. 21–3 (5 figs.).

Walmsley, W. H.—Some Hints on the Preparation and Mounting of Microscopic Objects. 2nd paper.
[Mounting in balsam in cells.]
The Microscope, I. (1882) pp. 161–72 (7 figs.).

Ward, E.—Micro-crystallization.
[Describes the mode of preparation of Micro-crystals.]
North. Microscopist, II. (1882) pp. 25–33.

White, M. C.—Examination of Blood-stains by Reflected Light.
[With Beck's (vertical?) illuminator and $\frac{1}{8}$ in. objective.]
Amer. Mon. Micr. Journ., III. (1882) p. 6.

Wightman, G. J.—Crystallized Fruit Salt.
[Recommended as an object for the Polariscope.]
Sci.-Gossip, 1882, p. 64.

Woronin, —.—Les meilleurs Liquides Conservateurs pour les Préparations Microscopiques. (The best preservative liquids for microscopical preparations.)
Rev. Mycol., IV. (1882) p. 71.

Zimmermann's (O. E. R.) Mykologische (mikroskopische) Präparate. (Mycological—microscopical—preparations.)
[General description by G. W.]
Hedwigia, XXI. (1882) p. 5.

PROCEEDINGS OF THE SOCIETY.

Annual Meeting of 8th February, 1882, at King's College, Strand, W.C., The President (Professor P. Martin Duncan, F.R.S.) in the Chair.

The Minutes of the meeting of 11th January last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Reinsch, P. F.—Neue Untersuchungen über die Mikrostruktur der Steinkohle des Carbon, der Dyas und Trias. viii. and 124 pp. and 94 pls. 4to. Leipzig, 1881	*Mr. Crisp.*
Iris-Diaphragm for Objectives	*Mr. C. Collins.*
Sections of Sugar-cane and Palm	*Dr. B. W. Richardson.*

The President, referring to Professor Reinsch's book, said it would be very desirable to have the mounted specimens which had been promised by him.* Without these it was impossible to determine whether the conclusions at which he had arrived were correct.

Mr. Crisp said that with regard to Dr. Richardson's slides it should be noted that the processes which he quoted as having been devised by Dr. Stirling were in reality due to Dr. H. Gibbes, whose descriptions had been taken by Dr. Stirling without acknowledgment of their original source.

Mr. Crisp also called attention to the Iris-diaphragm for objectives presented by Mr. C. Collins. The use of such a diaphragm had been originally suggested by Dr. Royston-Pigott, but was now revived by Mr. G. E. Davis, for the special purpose of obtaining penetration with wide-angled objectives by reducing their aperture (see p. 262).

The Treasurer, Dr. Beale, F.R.S., read his statement of the income and expenditure of the Society for the past year, which had been duly audited by the Auditors appointed at the last meeting (see p. 292).

Dr. Gray moved that the statement be received and adopted; and Mr. Michael having seconded the motion, it was put from the chair and unanimously carried.

A vote of thanks was given to the Treasurer and the Auditors.

The President, in pursuance of notice given at the previous meeting, read the proposed alteration in the Bye-law relating to the payment of subscriptions. He thought the alteration was one which would commend itself to the Fellows.

Mr. Crisp then moved that the words from "Fellows" to "year"

* See Journal, i. (1881) p. 712.

inclusive be omitted from Bye-law No. 6*a*,† and the following inserted:—"A Fellow elected in any month subsequent to February shall not, "however, be called upon for the whole subscription for the current "year, but for a proportional part thereof only; that is, if elected in "March or April he shall pay one pound fifteen shillings, in May or "June one pound eight shillings, in October fourteen shillings, or in "November or December seven shillings."

This was seconded by Mr. T. Charters White, and carried.

The Report of the Council was read by the President (see p. 293).

Mr. T. Charters White moved that the report be received and adopted and printed in the usual way, and the motion having been duly seconded, was put to the Meeting, and carried unanimously.

The List of Fellows proposed as Officers and Council for the ensuing year was read as follows:—

President—Prof. P. Martin Duncan, M.B., F.R.S.

Vice-Presidents—Prof. F. M. Balfour, M.A., F.R.S.; *Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.; *Robert Hudson, Esq., F.R.S., F.L.S.; John Ware Stephenson, Esq., F.R.A.S.

Treasurer—Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.

Secretaries—Charles Stewart, Esq., M.R.C.S., F.L.S.; Frank Crisp, Esq., LL.B., B.A., V.P.L.S.

Twelve other Members of Council—*Ludwig Dreyfus, Esq.; Charles James Fox, Esq.; James Glaisher, Esq., F.R.S., F.R.A.S.; *J. William Groves, Esq.; A. de Souza Guimaraens, Esq.; John E. Ingpen, Esq.; John Mayall, Esq., jun.; Albert D. Michael, Esq., F.L.S.; *John Millar, Esq., L.R.C.P. Edin., F.L.S.; *William Thomas Suffolk, Esq.; Frederic H. Ward, Esq., M.R.C.S.; T. Charters White, Esq., M.R.C.S., F.L.S.

Mr. Beck and Dr. Gibbes having been appointed Scrutineers, proceeded to take the ballot, and subsequently reported that the above-mentioned Fellows were all duly elected. A vote of thanks to the Scrutineers was unanimously carried.

Mr. Beck said it had been usual to regard a vote of thanks to the Secretaries as a matter of course, but he thought that at no previous time did they so much deserve that a hearty vote of thanks should be offered to them. The Society was very greatly indebted for their services, and it was not as a mere matter of form that he made the proposition that they should be thanked for the able manner in which the business of the Society was conducted.

The President thought there could be no difference of opinion upon this matter. The Secretaries were the very life and soul of the Society, and most heartily deserved their thanks. The motion was then put from the chair, and carried by acclamation.

Mr. Crisp in returning thanks for the vote on behalf of himself

† See Journal, iii. (1880) p. 736.

* Have not held during the preceding year the office for which they were nominated.

and his co-secretary, said that he felt there should be an amendment to the proposition so as to make it include the President and the other Officers of the Society instead of singling out the Secretaries alone. The President in particular had been most indefatigable in the attention which he had given to the affairs of the Society, and had especially distinguished himself by the way in which he had added by his comments to the interest of the matters brought before their meetings. There was he knew a very general desire that his term of office might be an extended one.

The President then read his Annual Address, which was warmly applauded by an appreciative audience (see p. 145).

Mr. Ingpen said he had much pleasure in proposing a vote of thanks to the President for his able and interesting address. He was sure that those who had followed the revival of the discussion of the aperture question would thoroughly agree that the last year had, as the President had observed, marked an important epoch, in that it had placed the matter on its true scientific basis, and had exposed the strange fallacies by which the previous consideration of the subject had been confused. The Address was one which he felt sure they would all be pleased to read when printed, and to remember. For his own part, he would venture to express the hope that the President would carry out his intention of continuing his record of progress in a similar manner at a future time.

Dr. Braithwaite having seconded the motion, Mr. Ingpen put it to the Meeting, and declared it carried by acclamation.

The President thanked the Fellows for the vote of thanks and also for the honour which they had done him in again electing him President. He had at first been doubtful as to how he should succeed in that office, for although he had occupied the Chair in other societies, he had been prevented from attending the meetings of this Society. He could only say that he would do his best during the term of office for which they had re-elected him, and hoped that at its termination he should receive their approval.

New Fellow.—Mr. W. A. Thoms was elected an *Ordinary* Fellow.

THE TREASURER'S ACCOUNT FOR 1881.

Dr.

1881.	£	s.	d.
To Balance brought from 31st December, 1880	102	18	8
„ Interest on Investments	84	15	9
„ Admission Fees	107	2	0
„ Annual Subscriptions	563	16	0
„ Composition	10	10	0
„ Journals sold by Assistant Secretary	2	11	0
„ Monthly Microscopical Journal (odd numbers) sold	11	11	6
„ Screw tools sold	12	12	6
„ Consols sold (Medal Funds)	198	10	0
	£1094	7	5

Cr.

1881.	£	s.	d.
By Rent, Gas, and Attendance	100	3	9
„ Salaries, Reporting, and Commission	142	19	6
„ Books and Binding	44	5	4
„ Expenses of Journal	339	4	0
„ Stationery and Miscellaneous Printing	13	3	3
„ Coffee at Evening Meetings	23	5	6
„ Fire Insurance	1	4	0
„ Cheque Book and Power of Attorney	0	15	8
„ Petty Cash and Postage of Journal (including balance in hand 5*l.* 9*s.* 4*d.*)	65	0	0
„ Alterations to Library	14	3	4
„ Screw tools	26	5	0
„ Medal Funds returned	200	0	0
„ Subscription to Mr. Bolton's Bottles	2	2	0
„ Cheque returned and Bank Charges	1	1	6
„ Balance remaining 31st December, 1881	120	14	7
	£1094	7	5

L. S. Beale, *Treasurer.*

Investments, 31*st December*, 1881.

1200*l.* Freehold Mortgages. 1057*l.* 13*s.* 3*d.* Three per cent. Consols (including 100*l.* Quekett Memorial Fund).

The foregoing Account examined and found correct, February 3rd, 1882.

J. Badcock, P. S. Butler — *Auditors.*

REPORT OF THE COUNCIL

presented to the Annual Meeting on 8th February, 1882.

New Fellows.

Having regard to the large number of new Fellows elected during the years 1879 and 1880, it might have been fairly expected that the new elections would now show some diminution. The Council are, however, gratified to find that during the past year 51 Ordinary Fellows were elected, as against 47 in 1880 and 58 in 1879.

Twenty-four Fellows have died or resigned (1 compounder, 22 subscribers, and 1 Honorary Fellow), and the list now stands as follows :—501 Ordinary, 49 Honorary, and 83 Ex-Officio Fellows.

The greatest number of Ordinary Fellows at any previous period of the Society's existence was 452.

Finances.

The income of the Society (excluding admission fees) now amounts to 728*l.*, being 636*l.* 6*s.* derived from subscriptions, and 91*l.* 14*s.* from investments. In accordance with the determination come to at the Annual Meeting in 1881, it is not intended in future to invest Compositions, except in the contingency mentioned in the Council's last Report.

Library, &c.

The additions to the Library are now so numerous that there is a difficulty in providing space for them on the shelves, and it is feared that the only remedy will be to discontinue some of the exchanges.

A catalogue of the Library has been prepared by the Assistant-Secretary, and checked by Mr. Fox, who has also kindly undertaken to prepare a catalogue of the property of the Society generally.

Meetings.

The attendance at the meetings of the Society has been well maintained, and if the Council were furnished with a greater number of papers, recording the results of original work on the part of Fellows, the position of the Society would leave hardly anything to be desired.

The Journal.

In accordance with the desire expressed by the Council, the last volume of the Journal has been somewhat reduced, and would have been brought within the limit of 1000 pages but for the pressure caused by the revived discussion of the aperture question.

With the completion of that volume Mr. Crisp's arrangement for the honorary editorship of the Journal terminated. The Council passed a unanimous resolution expressing their thanks for his valuable services in conducting and editing the Journal, and for the great liberality he had displayed in its production. Under the

special circumstances which existed, the Council did not feel themselves able to invite Mr. Crisp to continue to act as Editor; but having appointed a committee to confer with him on the subject, they were gratified to find that he was willing to continue the existing arrangement for two years further. The Council are sure that the Society will cordially endorse both their resolution as to the past conduct of the Journal and their satisfaction that it will be continued for a further period. The thanks of the Society are also due to the Associate Editors for their services in connection with the Journal.

MEETING OF 8TH MARCH, 1882, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (PROFESSOR P. MARTIN DUNCAN, F.R.S.) IN THE CHAIR.

The Minutes of the Annual Meeting of 8th February last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Arnold, J. A. F.—Die neueren Erfindungen und Verbesserungen in betreff der Optischen Instrumente. 232 pp. and 4 pls. (8vo. Quedlinberg, 1833)	*Mr. Crisp.*
Diatomaceous Earths from California	*Mr. H. G. Hanks.*

The President said that the Council had approved (under the 15th Bye-law) the recommendations of two Honorary Fellows to fill the vacancies in the list caused by the deaths of Messrs. Schleiden and Schwann, viz. (1) M. C. Robin, of France, well known as an histologist and microscopist, and the author of the 'Traité du Microscope et des Injections'; and (2) Dr. L. Dippel, of Germany, also an eminent microscopist, and the author of 'Das Mikroskop und seine Anwendung,' in which not only the Microscope but the histology of plants is ably dealt with.

Mr. J. Mayall, jun., described Wenham's Universal Inclining and Rotating Microscope exhibited by Messrs. Ross (see p. 255).

Mr. Crisp exhibited and described the Bausch and Lomb Optical Company's Trichinoscope (see p. 258); the "Hampden" Portable Simple Micròscope, lent by Sir John Lubbock, Bart. (see p. 258); two cheap American "Dissecting Microscopes"; one of Fasoldt's 19-band test-plates; Aylward's "Patent Micro-slide"; and Stokes's Tadpole-slide (see p. 110).

Mr. R. J. Lecky's note as to the origin of the glutinous character of spiders' webs was read.

Mr. Crisp described the composition of the two immersion fluids sent by Dr. Van Heurck, and exhibited at the December meeting (see pp. 133 and 264).

Dr. Ord described and figured on the black-board certain symmetrically-placed large nerve-fibres which he had discovered in the spinal cord of the pike, the axis-cylinders of these animals being of enormous size, at least seven or eight times the diameter of the largest axis-cylinder found in the human spinal cord, or so far as is known in any of the higher mammalia.

Mr. Stewart said that the presence of the large fibre described by Dr. Ord with its proportionately large axis-cylinder was a matter of considerable interest, and that he looked forward to Dr. Ord's further investigations, so that its connections might be determined and data derived for understanding its chief function.

The President said they were greatly indebted to Dr. Ord for his description and drawings, and expressed the hope that he would be able to lay before them during the present session the results of his further investigations so that they might be published in proper form.

Dr. Ord, in reply to a question as to the way in which he prepared the cords referred to, said that they were partly prepared with strong spirit, and partly with Müller's fluid with a considerably long immersion. For those that he was now preparing he used a bichromate of ammonium solution.

Mr. Crisp referred to the objection that had been raised to homogeneous-immersion objectives as regards their liability to be scratched (see p. 264).

Dr. Edmunds said that he had used homogeneous lenses from their earliest introduction, and that the surfaces of the front lenses were still as highly polished, and the objectives in fact in all respects as perfect now as they were at first.

Dr. A. S. Mercer's views as to stereoscopic vision with non-stereoscopic binocular arrangements were explained by Mr. Crisp (see p. 271).

Mr. Stewart described and exhibited a gold-stained preparation of the crop of a snail, showing the nerve-termination having occasional large nerve-cells (in groups of rarely more than two) connected with it. From these large fibres spring, and there were others much smaller with groups of nerve-cells, from which again proceeded fibres of exceeding minuteness, forming a dense intercommunication with a few mostly elongated nerve-cells connected with them. The latter was apparently the terminal nerve-plexus, and lay immediately beneath the epithelial lining of the pharynx.

The President said he was grateful to Mr. Stewart for so interesting a demonstration, which opened up a field well deserving the attention of some of the younger Fellows.

Mr. Stewart said that he did not in these experiments recognize the termination in the muscle-fibres, but that some of them do so there was no doubt.

Mr. Crisp, referring to a paragraph in the President's Address, explained the misconception involved in the use of miniatured images, so far as regards the supposition that thereby very minute fractions of an inch were visible.

The President announced that the Second Conversazione of the session would be held on the 26th April.

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—Various Rotifers.

Mr. Crisp:—(1) Bausch and Lomb Optical Co.'s Trichinoscope (p. 258). (2) Two cheap American "Dissecting Microscopes." (3) Fasoldt's 19-band Test-plate. (4) Aylward's "Patent Micro-Slide." (5) Stokes' Tadpole Slide (p. 110).

Sir John Lubbock, Bart.:—The "Hampden" Portable Simple Microscope (p. 258).

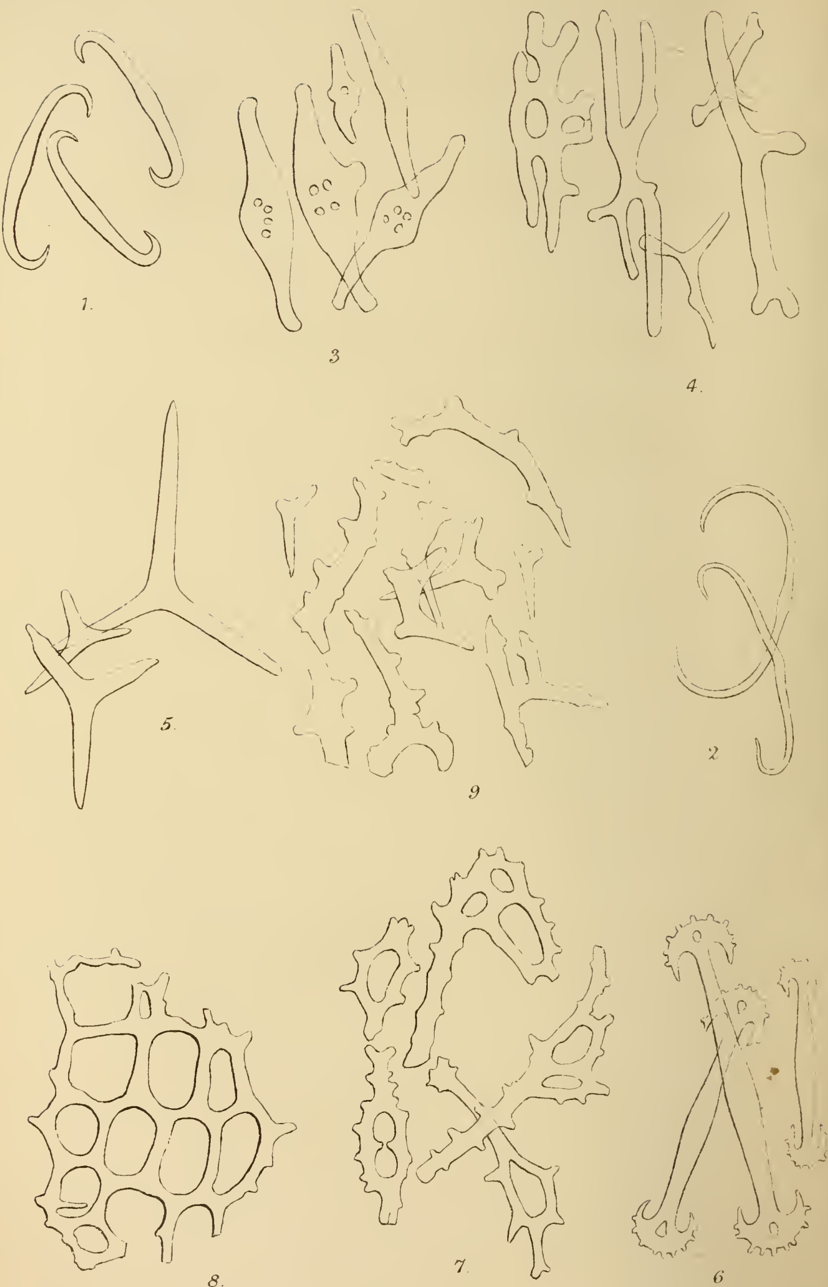
Dr. Ord:—Preparations illustrating his paper.

Messrs. Ross:—Wenham's Universal Inclining and Rotating Microscope (p. 255).

Mr. Stewart:—Pharynx of snail.

New Fellows.—The following were elected *Ordinary* Fellows:— Messrs. William A. Delferier, Wilson Noble, and Charles N. Peal.

WALTER W. REEVES,
Assist.-Secretary.



$\frac{1}{1000}$ in.

Spicules of Regular Echinoids.

Berjeau & Highley, del. et lith.

Mintern Bros. imp.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE 1882.

TRANSACTIONS OF THE SOCIETY.

VII.—*Note on the Spicules found in the Ambulacral Tubes of the regular Echinoidea.* By Professor F. Jeffrey Bell, M.A., F.R.M.S.

(*Read* 10*th May*, 1882.)

Plate V.

I have thought that it might be of interest to the Society to have some further information on the distribution of the spicules found in the ambulacral tubes of the regular Echinoidea. The greater part of our present knowledge on this subject we owe to the researches of one of our Secretaries, Mr. Charles Stewart, the most important of whose papers was published in the Linnean Society's 'Transactions' for 1865.* I have been enabled to examine a large series of genera and species, and as my leading object has been to find some further characters which would be of assistance in the classification of the groups and genera of the order, I have confined my attention at present to the sucking-tubes.

Commencing with the genus *Echinus*, I was struck by the constant presence in its species of those C-shaped or bihamate spicules, the characters of which will be known to every microscopist (Pl. V. Fig. 1). Carrying on these researches further, I

EXPLANATION OF PLATE V.

Fig. 1.—*Echinus* (*E. margaritaceus*), to show the ordinary bihamate spicules.
„ 2.—*Cottaldia* (*C. forbesiana*).
„ 3.—*Echinocidaris* (*E. dufresnii*).
„ 4.—*Echinothrix* (*E. turcarum*).
„ 5.—*Diadema* (*D. setosum*).
„ 6.—*Micropyga tuberculata*.
„ 7.—*Asthenosoma pellucidum*.
„ 8.—*Phormosoma bursarium*.
„ 9.—*Salenia hastigera*.

* Vol. xxv. p. 365.

found that every genus of the so-called Triplechinidæ which I examined contained these same bodies; similarly they were to be found in the other division (Temnopleuridæ) of the Echinidæ, as limited by Professor Alexander Agassiz. Nor were they here only; when the suckers of the Echinometridæ were examined, the bihamate spicules were again to be observed. In the Cidaridæ, Salenidæ, Echinothuridæ, Echinocidaridæ, and Diadematidæ, the bihamate spicules were, on the other hand, conspicuous by their absence; and this being so, I found in their distribution among various genera of the Echinometridæ and Echinidæ a gratifying support to the view on which I have elsewhere † insisted, that these two groups differ less from one another than they do from any other group of the regular Echinoids. It may be worth while to give the names of the genera examined :—*Heterocentrotus*, *Colobocentrotus*, *Echinometra*, *Echinostrephus*,* *Strongylocentrotus*, *Sphærechinus*,* *Pseudoboletia*,* *Temnopleurus*, *Salmacis*, *Mespilia*, *Amblypneustes*,* *Microcyphus*,* *Cottaldia*,* *Echinus*, *Tripneustes*, *Toxopneustes*,* *Evechinus*.*

The number of genera examined is now sufficiently large to justify us in the belief that C-shaped spicules will always be found in the suckers of the Echinidæ, as I have proposed to define the term.

With regard to the form here called *Cottaldia*, it may be added that the specimen was collected by the 'Challenger,' and that, therefore, it was determined by Prof. Alex. Agassiz; a reference to that naturalist's report will sufficiently prove that he has had considerable difficulty in finding a place for the species; that difficulty cannot, however, extend to its general position, now that the spicules have been examined, and been found to be of the bihamate type (Fig. 2).

With regard to the Diadematidæ, we have to note that, if the forms have been correctly united, there is not the same closeness in the characters of the ambulacral spicules in this group as there is in that of the Echinidæ; though we can imagine a connection between the spicules of *Echinothrix* (Fig. 4), and those of *Diadema* (Fig. 5) it hardly seems possible to associate with them those of *Micropyga* (Fig. 7) or of *Astropyga*, which have so striking a Holothurian facies, and no generalization can safely be made at present for this division.

When Mr. Stewart published his paper in 1865 he had been unable to find spicules in the ambulacral tubes of *Echinocidaris* (*Arbacia*). I, too, was for a time unable to find them, but at last they were detected; they are but scantily present, but are very characteristic, being greatly widened in the middle, and frequently

† Proc. Zool. Soc. Lond., 1881, p. 418.
* Those marked with an asterisk were not reported on by Mr. Stewart.

perforated in that portion (Fig. 3). It would seem likely that the rarity of these spicules may be ascribed to the great thickness of the walls of the suckers, the development of muscular and connective tissue being so considerable that there is no such necessity for the spicules here as there is in cases where the walls are thinner; but the spicules themselves are proportionately large.

The bihamate spicules of the Echinidæ, the tri-radiate ones of *Diadema*, the flattened centrally enlarged form of *Echinocidaris*, present little in common, and, while there would be no difficulty in distinguishing them, it is likewise impossible at present to make a suggestion as to how they might be derived from one another. When with these we compare the ambulacral spicules of *Salenia* it is not perphaps too hardy to suggest that in the irregular forms there to be found we may have something hardly more than "amorphous," from which the forms of the later groups have been derived.

There is no close resemblance between the spicules of *Cidaris* * and those of *Phormosoma* and *Asthenosoma* (Figs. 8 and 9); the reticular character of the spicules of the Echinothuridæ is doubtless to be associated with the comparative tenuity of their tests.

* See Stewart, Quart. Journ. Micr. Sci. xi. (1871) pl. iv.

VIII.—*The Relation of Aperture and Power in the Microscope.**

By Professor Abbe, Hon. F.R.M.S.

(*Read* 10*th May*, 1882.)

I.—*General Considerations as to Wide and Narrow Apertures.*

The question of the relative values of high and low apertures has been much obscured by the one-sidedness with which it has been treated. One party of microscopists—the "wide-aperturists"—having recognized that high apertures are capable of exhibiting minuter details than low apertures, conclude therefrom that *all* microscopical work must be done with very wide apertures, and that low-angled systems are worthless. Another party, relying upon the fact that there are many cases in which low or moderate apertures perform decidedly better than wide ones, generalize this experience and deny that there can be any essential benefit in very wide apertures, asserting that all observations, with the possible exception of resolving diatom striæ, can be done as well with low-angled objectives. The premises of both these views may be said to be true, but true *under conditions* only; and by disregarding these conditions both parties arrive at conclusions which are equally remote from a proper estimation of the requirements of scientific work with the Microscope. My view of the question † is based on the following considerations:—

1. Every given degree of minuteness of microscopic detail requires a given aperture in order to obtain a complete (or perfect) image, i. e. an image which is a *true* enlarged projection of the structure, exhibiting all elements in their true form and arrangement. The minuter the dimensions of the elements the wider an aperture is *necessary*—the larger these dimensions the narrower an aperture is *sufficient*. Structures whose smallest elements are measured by considerable multiples of the wave-lengths of light are perfectly delineated with low or very moderate apertures, and their examination with wide apertures does not improve their recognition. On the other hand, if we are dealing with objects whose dimensions (or structural elements) are equal to a few wave-lengths only, even the

* The paper (received 8th April) is written by Professor Abbe in English.

† As some suggestion appears to have been made when the above paper was read as to my views having undergone a change, I beg to remind my readers that the views above explained are those which I have professed since 1873—the date of my first paper on the subject. My advocacy of wide apertures for *minute* objects appears to have been interpreted as an advocacy of wide apertures for all purposes—a misapprehension which I am at a loss to account for, as nothing I have ever said or written could justify any such a supposition.

All the catalogues of Mr. Zeiss issued since 1872 give practical evidence of this, as the objectives there specified (and stated to be constructed according to my principles and under my direction) include no low and medium powers, *except with low or very moderate apertures*.—E. A.

widest apertures hitherto obtained will not afford complete or strictly true images, but will show these objects more or less incomplete or modified. This general principle holds good in regard to objects of every kind, regular or irregular, isolated particles or composite structures, because the physical conditions of microscopical delineation are always the same.

The obvious inference from this principle is that the widest possible apertures must be used for the observation of objects or structures of very minute dimensions, low and moderate apertures for relatively large objects.

It may perhaps be said that the objects of microscopical research do not justify such a distinction of large and minute, since the works of nature are always elaborated to the minutest details, all coarse objects being composed of smaller elements, and these of still smaller ones, &c. This is quite true in regard to the objects considered as natural things, but not as objects of scientific research. The interest of research is not always directed to the ultimate elements, but is as often confined to the consideration of the coarser parts, and in such cases the observer is not only allowed but sometimes compelled, to disregard everything which is not connected with the scientific aim of his investigation. To observe every object in nature throughout, from alpha to omega, is the privilege of dilettante microscopy only, which has no distinct aim. There are many lines of the most valuable scientific research (e. g. the greatest part of all morphological investigations) which have not to deal with very minute things. This kind of work can be completely done with low or moderate apertures.

To recommend the application of wide-angled objectives for every branch of microscopy, as has been, in fact, done by excited wide-aperturists, is no more to be supported than it would be to recommend the use of a magnifier to a painter for inspecting the tree which he proposes to delineate.

According to what has just been said, the only benefit of greater aperture is that it is capable of delineating *minuter* things. Now minute dimensions require high amplifications in order that they may be enlarged to a visual angle sufficient for distinct vision. Low figures of amplification cannot render visible (at least not distinctly visible) details which are beyond a certain limit of minuteness. Even if they are delineated by the Microscope they would remain hidden to the eye for want of sufficient visual angle. It follows therefore that wide apertures will not be utilized unless at the same time there is a linear amplification of the image, at least sufficient for exhibiting to the eye the smallest dimensions which are within the reach of such an aperture. On the other hand, a high amplification will be useless if we have small apertures which delineate details of dimensions only capable of being

distinctly seen in an image of much lower amplification. We have here an empty amplification, because there is nothing in the image which requires so much power for distinct recognition. In the first case (deficiency of power) the large aperture cannot show more than a smaller one; in the other case (deficiency of aperture), the high amplification shows no more than a lower would do. Consequently:—

Wide apertures when high amplification is required; low or moderate apertures when low or moderate amplifications are sufficient or cannot be overstepped.

2. The utilization of a given aperture depends in principle on the amplification of the *ultimate* image which is projected by the entire Microscope to the observer's eye. Now one and the same amplification may be obtained in very different ways since it is the resultant of three distinct elements, (*a*) focal length of the objective, (*b*) focal length of the ocular, and (*c*) length of the tube. Any definite number of diameters (say 1000) can be obtained with a low power objective (say a 1-inch) as well, from a mere dioptrical point of view, as with a higher power (say $\frac{1}{8}$-inch), by applying a sufficiently deep eye-piece and a sufficient length of the tube. It is, however, well known that there is a great difference in the optical qualities of images which are produced under these different conditions. Forcing a high amplification from a low-power objective is always connected with a considerable loss of sharpness of definition of the image, owing to the magnification of the residuary aberrations, which are inherent even in the most finished constructions. It is, therefore, a well-established practical rule that a certain amount of amplification requires a certain power of the *objective*—higher amplification a higher power (shorter focal length)—in order to obtain the image under those favourable conditions which are necessary for their full effectiveness. This considered, the inference of the foregoing paragraph may be expressed in these terms:—

Wide apertures with objectives of short focal length; low and moderate apertures with objectives of low and moderate power.

As a detailed discussion of this subject will be found in the second part of this paper, it will be sufficient here to point out some notable facts of experience by way of example only.

With objectives of say 1 inch, and $\frac{1}{2}$ inch, focal length, the lower and medium eye-pieces in use will yield 40–80 and 80–160 diameters only. In order to obtain 150 and 300 respectively, very deep oculars (or an extra length of the tube) would be required. So far now as such objectives are intended for the lower powers mentioned above, an aperture of about 0·15 (18°) in the case of the 1-inch, and of 0·3 (35°) in the case of the $\frac{1}{2}$-inch, are at all

events more than sufficient for showing every detail which can possibly be recognized by the eye under these amplifications, and therefore wider apertures are useless. In point of fact, no observer will see anything more or anything better with similar objectives of say 0·40 (48°) and 0·75 (96°) respectively, than with the narrower angles indicated above, as long as the low and medium oculars are in question only. These latter apertures would require for their full utilization, i. e. for convenient observation of the minuter details which are within their reach, amplifications of much more than 150 and 300 diameters. With well-made objectives of those apertures, such figures may be realized indeed, and details may be shown by means of deeper eye-pieces, which remain quite invisible with the lower angled systems; but no microscopist can deny the inferior quality of the images obtained in this way if compared to those of equal amplification, which are obtained with these same apertures when the objectives have double the power and the oculars the half only. Structures of so simple a composition as diatom striæ may perhaps be tolerably displayed under such forced amplifications of low-power objectives, but with objects of somewhat irregular and complicated structure the deterioration of the image attendant upon a considerable enlargement of the residuary spherical and chromatic aberrations by deep eye-pieces, becomes at once obvious even with the most finished objectives. In point of fact, no experienced histologist will ever use in ordinary work even an ocular amplification of the amount necessary for obtaining 100 diameters from a 1-inch objective or 200 from a $\frac{1}{2}$-inch. He would be unwise if he troubled himself with inferior images whilst good images of the amplifications required could be obtained with equal, or even greater, convenience with objectives of the same apertures but half the focal length.

The above is an example of waste of aperture, or lack of useful power; waste of power and lack of aperture are exemplified by every objective of excessively short focal length, e. g. $\frac{1}{50}$ inch. Such a lens, even if immersion, cannot be made with an aperture of much greater numerical value than 1·0, in consequence of the technical obstacles arising with such very short focal lengths. Now the limit of an aperture of that amount is entirely exhausted, at all events with a power of 1000 to 1200 diameters, inasmuch as nothing of the real attributes of an object can be seen with that aperture under a higher amplification, which could not be as well recognized under the lower. A $\frac{1}{50}$, however, will yield 1500–2000 diameters with the lowest eye-pieces which are usually employed. The lowest attainable power is therefore an empty power already, and every useful amplification available with the aperture in question could be obtained under favourable conditions and with much less inconvenience by an objective of half the power, or even less.

3. The preceding shows that wide apertures can only be utilized in the observation of minute details, under high amplifications obtained with objectives of short focal length. Wide apertures are therefore useless when those conditions are not fulfilled, because in this case the same result could be obtained as well with low-angled systems. But as abundance *primâ facie* is no detriment, the foregoing considerations do not enforce any positive objection to the use of wide apertures for every kind of work. There are however other points of view from which it becomes obvious that the application of wider apertures than can be utilized is not merely superfluous but is a decided disadvantage, inasmuch as they prevent the utilization of some really valuable benefits which are the privilege of low and moderate apertures.

The first disadvantage results from the reduction of the depth of vision (or the "penetration" of the Microscope) which is connected with wide apertures. I have given in another place* a discussion of the circumstances on which penetration depends, and the formulæ which afford an approximate numerical estimation of the depth of vision in microscopic observation. These theoretical suggestions show (in accordance with the experience of practical microscopists) the reduction of penetration with increasing aperture under one and the same amplification, and especially when the amplification is not restricted to very small figures. Now there are many objects of microscopical research which do not require, and, indeed, do not even admit of high powers, but demand for effective investigation as much penetration as possible. This is always the case where the recognition of *solid* forms is of importance, and therefore a distinct (at least, a tolerably distinct) vision of different planes at once must be possible, whether the observation is assisted by stereoscopic devices or not. The greater part of all morphological work is of such a kind, and in this line of observation therefore a proper economy of aperture is of equal importance with economy of power.

Whenever the depth of the object under observation is not very restricted, and it is essential that the depth dimension shall be within the reach of direct observation, low and moderate powers cannot be overstepped, and no greater aperture should therefore be used than is required for the effectiveness of these powers—an excess in such a case is a real damage. High powers and correspondingly wide apertures are restricted to those observations which do not require any perceptible depth of vision, i. e. to two different cases (1) when the objects are quite flat or exceedingly thin; (2) when preparations of greater depth are sufficiently transparent to admit of an *indirect* recognition of their solid structure

* See this Journal, i. (1881) p. 689.

by means of successive optical sections through *successive* focussing of different planes. For the latter method of observation the loss of penetration with increasing power and aperture is no drawback, but rather an advantage, because it enhances the distinct separation of the sectional images at successive foci. A disregard of these natural restrictions in the use of wide apertures is obviously the origin of the opinion that aperture *per se* is antagonistic to good definition. It is quite true that there are many even very delicate objects which are much better seen under a given amplification with a system of very moderate than with one of very wide aperture, the former giving a clear view of the whole structure, the latter showing perhaps some distinct points, but as a whole veiled in haze. Provided, of course, that we have well-corrected objectives, the fault here is not on the part of the lens, but on the side of the object, which requires for proper recognition a greater range of depth than is reconcilable with a wide aperture. The theoretical suggestion which has been brought forward in support of the notion that different parts of the clear area of an objective produce *dissimilar* images, and that *therefore* the resultant image must show increasing confusion with increasing aperture, cannot apply to the delineation of a plane object. In a well-corrected objective the partial pictures received through the various parts of the aperture-area are always strictly similar so far as one plane of the object is concerned. The confusion suggested is nothing else but confusion of the images of *different depths*—lack of penetration, but not lack of "definition" in any reasonable sense of that term. Provided the objectives are properly corrected and the objects are fit for the delineation of an image, undisturbed by interfering confused images from other planes, the "defining power" of an objective is always greater with greater aperture for every kind of objects, inasmuch as under all circumstances the wider aperture admits of the utilization of higher amplifications than can be obtained without perceptible loss of sharpness (with the same objects) by lower apertures.

There is therefore no drawback in principle to the use of a large aperture when the objects are suitable. But the considerations above lead to the conclusion:—

> *Wide apertures (together with high powers) for those preparations only which do not require perceptible depth of vision, i.e. for exceedingly flat or thin objects, and for transparent objects which can be studied by optical sections. Moderate and low apertures when a wide range of penetration cannot be dispensed with.*

4. There is still another point of view, and one of special practical importance, which shows the positive damage connected with the use of *unnecessarily* wide apertures. The increase of

aperture is prejudicial to the ease and convenience of microscopical work in two essential respects.

1stly, It necessitates a progressive reduction of the working distance of the objective. Owing to the rapid increase of the anterior aberration with increasing obliquity of the marginal rays (particularly in the case of dry lenses), perfect correction of a system cannot be obtained unless the layer of low refraction between the object and the front lens (i. e. the working distance) is reduced to a certain fraction of the focal length of the system, which fraction is necessarily diminished in a rapid proportion as the aperture becomes greater and greater. Whilst there is no objection to retaining as working distance $\frac{7}{10}$ of the focal length for an aperture of 30°, if the aperture is 60° not more than $\frac{3}{10}$ can be allowed, and with an aperture of 116° really good correction is not reconcilable with a working distance exceeding $\frac{1}{10}$ of the focal length. It is therefore an obvious disadvantage to use aperture angles of 60° and of 116°, when the power which is required or available can be obtained with 30° and 60° respectively.

2ndly, Increase of aperture is inseparable from a rapid increase of sensibility of the objectives for slight deviations from the conditions of perfect correction. The state of correction of an objective depends on the thickness of the refracting film between the radiant and the front lens, represented by the cover-glass and that portion of the preparation which is above the actual focus. This is a variable element independent of the objective itself. In order to avoid large aberrations which must result from the change of that element, its variation must either be confined to narrow limits or must be compensated for by a corresponding change in the objective. Now there is a great difference in regard to this requirement between the objectives of low and of wide aperture, in particular with the dry system. An objective of a few degrees is almost insensible, it may be focussed to the bottom of a trough of water without any loss of performance. With 30° differences in the cover-glasses within the usual limits are still inappreciable, and an object may be seen at the depth of a drop hanging on the under surface of a cover-glass. With 60° a deviation of the cover-glass from its standard thickness by not more than 0·1 mm., or a corresponding increase of the depth of the preparation above the actual focus, will introduce perceptible aberrations and a visible loss of definition if not compensated for. With an aperture exceeding 100° in a dry lens, the same result will arise from a change of thickness of 0·02 mm. only. To preserve always the best correction in such a system would necessitate a change of the correction-collar for almost every change of focus in the inspec-

tion of successive layers, unless the preparation is exceedingly thin.*

So far as the necessity of obtaining a certain amount of amplification in an efficacious manner *requires* a certain aperture, the above-mentioned restrictions and difficulties in the proper management of the objectives cannot be avoided. But all restrictions in regard to the objects, and all the trouble taken in the adjustment of the objectives, is quite for nothing when the same result can be obtained with a lower aperture. If for the sake of convenience the precautions required in the use of wide-angled lenses should be disregarded in working with the lower powers of wide aperture, the performance of such lenses is always *worse* than that of much narrower apertures under the same amplification. The best wide-angled system, if not carefully adjusted when in use, is not better than a *bad* low-angled lens, for the tolerably sharp image, which could be still obtained through the central part of the aperture alone (even under the imperfect state of correction) is disturbed by the coarse dissipation of light from the ineffective marginal parts of the aperture.

The amateur who likes the Microscope for his amusement may not much object to some extra trouble connected with the use of

* The reduction of this sensibility in somewhat large apertures is one of the great practical advantages of the immersion-method. The extreme increase of that sensibility which is met with when the aperture of *dry* lenses approaches the maximal value of a for air (1 N.A.), is in my opinion a strong objection to the construction of such lenses with greater apertures than 0·80–0·85. Not only in this case must the working distance be reduced to an intolerably small amount in order to obtain proper correction, but the preservation of that correction in the practical use of the systems is almost impossible, notwithstanding the correction-collar, whilst at all events the very slight benefit of optical performance is not worth speaking of in comparison to the large increase obtained with the immersion-method under so much more favourable conditions.

I need scarcely point out here that the claim of a *special* insensibility of certain lenses in regard to differences of the cover-glass (as has been sometimes made) is, to say the least, either great thoughtlessness or simple self-delusion, just as are similar claims of *special* penetration in favour of certain objectives. The aberrations in question, as well as the dissipation-circles from difference of focus, originate *outside* the Microscope. The particular construction of the objective cannot possibly therefore influence their amount in a cone of rays of given aperture, and the degree in which both become *visible* in the ultimate image of the Microscope must be strictly determined by the same elements which determine the visibility of any real object of given dimensions at the same plane of focus. There is no room left, therefore, for special properties of different constructions.

It is, however, true that an *apparent* insensibility, as well as an apparent depth of focus, is sometimes found, viz. in *badly* corrected objectives. When a system has no distinct focus at all, it is quite evident that the dissipation-circles arising from different thicknesses of the cover-glass, and from the difference of focus of different levels, may become much greater before the deterioration of the indistinct image becomes visible. Well-corrected objectives *must* be sensitive in both respects in strict accordance with their aperture so far as one and the same system of construction (dry or immersion) is in question.

wide-angled low-power lenses, which he admires as brilliant specimens of optical art. For those, however, who *work* with the Microscope, the economy of labour to which they are obliged will be expressed by the rule:—

> *Never use wider apertures than are necessary for the effectiveness of the power, because excess of aperture is always waste of time and labour.*

5. A few remarks about another point of practical interest. By those who plead in favour of large apertures *in all cases*, it has been sometimes suggested as a rational plan for reconciling opposite demands, to have all objectives constructed with relatively wide angles, and to reduce them by stops or diaphragms when smaller angles are desired. The greater penetration and insensibility of the low apertures may of course be attained thereby: but nevertheless this device is only a makeshift, and the result is inferior to that obtained by objectives *originally* arranged for a lower aperture. It is not merely that the stops cannot increase the working distance (which will always remain at the point corresponding to the full aperture of the lens), but that the low-angled lens which is made out of a *good* wide-angled one by means of a stop, is in optical respects a relatively *bad* objective—not nearly as well corrected as the same power would be if carefully adjusted for the lower angle. The reason will be readily understood from the following consideration.

The best correction of an objective of given aperture depends on the proper *distribution* of a certain amount of residuary aberration, which cannot be eliminated with our present means. The greater the aperture the more aberration must be intentionally left *at the central part of the system* in order to prevent an obnoxious accumulation in the marginal zone. It is obvious, therefore, that with an aperture-angle of say 90° the inmost cone of 45° cannot be so well corrected as it might be if the marginal zone could be left out of account. The effect is by no means inconsiderable, particularly in regard to the colour corrections. Owing to the chromatic difference of the spherical aberration the central portion of a somewhat wide aperture must always, even in a well-arranged objective, be perceptibly under-corrected chromatically, and in using this central part alone (the compensating influence of the over-corrected marginal zone being done away with), we have the performance of an inferior lens. In point of fact, no intelligent optician would ever make an objective of 30° aperture on the same formula as one of 60°, or one of 60° on the same formula as another of 100°, though this could be done by merely reducing the clear diameter of the lenses.

There cannot, therefore, be a reconciliation between the pleasure of exhibiting mere optical accomplishment and the interests of the

working microscopist. Bad lenses will certainly not meet the demand for low and medium powers affording the utmost possible economy of time and labour in scientific work. This can be done only by systems in which all advantages attendant upon the lower apertures are fully realized by constructions specially aiming at the *best* which can be obtained under the actual conditions of the case.

The *progressive increase of aperture in the higher powers*, formerly within the capabilities of the dry system, and at a later period by the development of the immersion method, is, without any reasonable doubt, the most important feature of the *modern advance of microscopical optics.* It has rendered possible the successful extension of microscopical research to minuter and minuter objects, which otherwise would have been impossible by the ineffectiveness of all increase of amplification beyond certain low figures. The appreciation of that progress and the recognition of its true basis has led to a tendency to increase more and more the aperture of *every* kind of objectives. The fact has been disregarded that it is an entirely different thing whether the object is to promote the performance of the Microscope *in the whole* at the limits of its power, or to promote its performance for aims beyond these limits. The opinion has thus arisen that what is a benefit for one kind of lenses must also be a benefit for every other kind. Objectives of low and medium powers (1-inch to ¼-inch) of 15° to 60° are proclaimed at this time by many microscopists as old-fashioned and worthless things; 45° to 100°, or even 60° to 140°, are wanted for the same powers. Now as from a purely technical point of view, it *is* an accomplishment when the delineating power of an objective cannot be exhausted even with the deepest eye-pieces, opticians (notwithstanding the total bootlessness of such a superabundance) of course take pleasure in making such "superior" lenses, and the natural consequence is that the lower apertures required for useful scientific research are likely to be esteemed as second-rate work, no longer worthy of high technical art.

This opinion is a fatal mistake, and its practical effect, if not counteracted, will be a decided retrogradation of microscopical optics. Nobody, of course, can have the least objection to the construction of lenses of any descripition whatever for the personal pleasure of this or that microscopist. Strong opposition should, however, be made against all tendencies of captivating microscopical optics, in favour of such predilections, at the cost of the general usefulness of the instrument.

> *Scientific work with the Microscope will always require not only high-power objectives of the widest attainable apertures, but also carefully finished lower powers of small and very moderate apertures.*

IX.—*The Bacteria of Davaine's Septicæmia.*

By G. F. Dowdeswell, M.A., F.R.M.S., F.C.S., &c.

(*Read* 10*th May*, 1882.)

The organisms here shown under the Microscope, and which occur in the blood of the rabbit, in the form of septicæmia known as that of Davaine (one of the first who described it, about twenty years ago), are remarkable, in many respects, from a microscopical point of view, and possess a general interest from their relation to the affection in which they occur, and which has been regarded almost as the type of a specific parasitical disease, from the circumstance that the blood of an animal in these cases is infective in inconceivably small quantities. The statements of Davaine on this point, which attracted so much attention, were that the trillionth,* or the ten-trillionth part of a drop of this blood was infective.

His experiments were repeated by several observers, who confirmed his results in different degrees. I have myself found, in numerous experiments, that in the case of rabbits the blood is usually infective up to the millionth and the hundred-millionth part of a drop; sometimes in even smaller quantities, obtained by successive dilutions.

In such blood I have found that the organisms here described always occur, but in very variable numbers; in some cases not more than one or two are to be found in each field of view, in others they exceed many times the number of the blood-corpuscles; they do not appear to increase in any marked manner shortly after death, as is the case in some other affections. The microphyte itself is a form of *Bacterium*, in the generic sense of the term, as defined by Cohn; its diameter, which varies less than that of any other form of Schizophyte which I have examined, is just over half a micromillimetre ($0 \cdot 509\ \mu$), almost exactly $\frac{1}{50000}$ m. The length which, in different stages of development, is very variable, may be put down at from $1\frac{1}{2}$ to 2, 3, or, in a few cases, 5 times the diameter, that is, of the single cells, or rods as they are commonly termed; two or three of these, but not more, sometimes occur united together, endwise, forming short chains; but they never, in the blood of an animal, form either long leptothrix filaments or zooglœa masses. They frequently appear in the form of a figure of 8, or a dumb-bell; this, as is shown in stained preparations—an example of which may be seen in the field of view under the Microscope—is not due to a constriction of the cell-wall, indicating incipient fission, but to a difference in its constituent parts and their refractive power; the

* A trillion in the French notation is a billion in the English, i. e. a million squared.

two ends are the most highly refracting, they take the staining more deeply than the intermediate portion, which is often with difficulty perceptible; the ends thus stained present the appearance of forming spores, in some cases so distinctly that I am disposed to think this is really the case, though I have never witnessed their complete development.

The preparation shown is from the blood of a rabbit of the third generation of artificial infection, it was made very shortly after death, and treated by the methods introduced by Weigert and Koch, which have been described elsewhere, and are now pretty generally known and adopted. I have not found these Bacteria in any of the organs or the tissues, excepting the blood and the lymph of an infected animal, examined immediately after death, not even in the lungs or the spleen, where, judging from other cases, we should expect to meet with them; their minute size, however, and more especially their not readily staining, would render them very difficult to distinguish in the tissues. In the blood this *Bacterium* is evidently motile, sometimes very actively so.

Notwithstanding the interest and attention which this affection has excited during several years, and the importance of the microphyte in relation to the question of the true nature of the contagium, it has not, I believe, been figured or at all carefully described by any one, excepting only by Coze and Feltz, in a work published at Strasbourg and Paris several years ago; their description is imperfect, and does not in any way coincide with my own observations; they even give the diameter of the organism just three times as great as I have found it. These measurements I have checked by the use of the admirable standard stage micrometer recently constructed by Professor Rogers, of Cambridge, U.S.A., one of which I have received, and which is most valuable in enabling different observers to compare exactly their measurements. The immense discrepancy, however, between my observations and those of Coze and Feltz, cannot be reconciled by any variations in the standard scale used, and renders it difficult to believe that the same organism has been observed in the two cases. This opens up a very important, indeed a fundamental question with reference to the etiology of this affection, which need not be discussed here; I will only say that in the course of very numerous experiments, in different series, I have found the organism specifically distinct, invariable and constant in all cases, thereby conforming to the first and most important condition which has been laid down as a test for a specific parasitical contagium.

In relation to the dimensions of the organism, and the infective virulence of the blood in which they are contained, a very curious question arises as to how many Bacteria or their germs can be contained in a given quantity of blood, and this, as far as I know,

has never been yet considered or referred to. Taking the dimensions of the Bacteria to be, diameter $0 \cdot 5\ \mu$, which is a fraction less than the actual measurement, and the length to be 2 diameters, which is undoubtedly under the average, a very simple calculation shows that in a drop, taken as the 16th part of a cubic centimetre, there would be 250,000,000,000 (two hundred and fifty thousand million), or just a quarter of a billion; this would be when the blood was entirely filled with, or rather replaced by a solid mass of Bacteria, leaving no space at all for the blood-corpuscles and but little for the plasma; and this is the utmost number which a drop could contain. I think it is evident, therefore, that there is some fundamental error in Davaine's statement and in that of those who have followed him, on this point. I have endeavoured directly to enumerate the number of Bacteria present in different portions of blood, but I cannot pretend to have succeeded with even approximate accuracy; the greatest number I could enumerate or estimate was a few millions in a drop.

Another point of special interest in this affection is the asserted increase in the infective virulence of septicæmic blood in successive generations of transmitted infection. This theory was explicitly maintained by Coze and Feltz, but Davaine's statements on the subject have been somewhat misunderstood, for although he asserted this in the fullest extent at first, he ultimately qualified the statement in some measure by showing that the maximum of virulence is reached very early; subsequent observers overlooked this qualification, and repeated and even improved upon Davaine's original statements. This question has again lately attracted attention in connection with the relation of micro-organisms to disease, and the sensational and, were they to be credited, appalling statements that have been made, and even supported, by high authority, asserting a transformation of physiological species in some of the lower organisms, which hypothesis, it was supposed, might be connected with or account for an increase in infective virulence in the organisms present in septicæmic blood in successive generations. On this point I shall only say that I have found in a long series of experiments recently made, that although the infectivity of such blood may be slightly variable, there is no such thing as progressive increase of virulence in successive generations; the blood of the first generation is actively infective in the millionth or the 100-millionth of a drop, or less, and it is not, and indeed for the reasons already stated, cannot be infective in very much smaller quantities, in the 25th nor any succeeding generations, nor is there any shortening of the incubation period, which in the large majority of cases is remarkably constant, ranging from twenty-one to twenty-four hours.

The relation of the organisms here described to the disease in

which they occur, has recently been the subject of experiment in Germany; I shall only say with regard to this that on investigating this question, it appears to me clear that the *Bacterium* does constitute the specific virus, the actual contagium of the affection.

The importance of the relations of these microphytes to disease, and indeed their rôle in the whole economy of nature is now so generally acknowledged that it is unnecessary to dwell upon it. It is only quite recently that the subject has been systematically developed, and already most valuable results have been attained, some of which, in regard to a most important practical application, viz. to tubercular disease, have only been communicated during the last month, and demonstrated in this College in the present week. It is by the microscopical examination of the organisms and the determination of their specific morphological characters alone, that many of the most weighty questions which present themselves can be determined. There is no field of microscopical research which requires more care or better optical appliances than these organisms, and none more worthy the attention of microscopists.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Germinal Layers of the Chick.†—Professor F. M. Balfour and Mr. F. Deighton record the results of a renewed study of two much disputed points in the ontogeny of birds, viz. the origin of the mesoblast and the origin of the notochord.

1. With reference to the first of these, their results are briefly as follows :—

The first part of the mesoblast to be formed is that which arises in connection with the primitive streak. This part is in the main formed by a proliferation from an axial strip of the epiblast along the line of the primitive streak, but in part from a simultaneous differentiation of hypoblast cells also along the axial line of the primitive streak. The two parts of the mesoblast so formed become subsequently undistinguishable. The second part of the mesoblast so formed is that which gives rise to the lateral plates of mesoblast of the head and trunk of the embryo. This part appears as two plates—one on each side of the middle line—which arise by direct differentiation from the hypoblast in front of the primitive streak. They are continuous behind with the lateral wings of mesoblast which grow out from the primitive streak, and on their inner side are also at first continuous with the cells which form the notochord.

In addition to the parts of mesoblast, formed as just described, the mesoblast of the vascular area is in a large measure developed by a direct formation of cells round the nuclei of the germinal wall.

The mesoblast formed in connection with the primitive streak

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Quart. Journ. Micr. Sci., xxii. (1882) pp. 176–88 (3 pls.).

gives rise in part to the mesoblast of the allantois, and ventral part of the tail of the embryo, and in part to the vascular structures found in the area pellucida.

With reference to the formation of the mesoblast of the primitive streak, the authors' conclusions are practically in harmony with those of Koller; except that Koller is inclined to minimize the share taken by the hypoblast in the formation of the mesoblast of the primitive streak.

Gerlach, with reference to the formation of this part of the mesoblast, adopts the now generally accepted view of Kölliker, according to which the whole of the mesoblast of the primitive streak is derived from the epiblast.

As to the derivation of the lateral plates of mesoblast of the trunk from the hypoblast of the anterior part of the primitive streak, the authors' general result is in complete harmony with Gerlach's results, although in their accounts of the details of the process they differ in some not unimportant particulars.

2. As to the origin of the notochord, their main result is that this structure is formed as an actual thickening of the primitive hypoblast of the anterior part of the area pellucida. It unites posteriorly with a forward growth of the axial tissue of the primitive streak, while it is laterally continuous at first, both with the mesoblast of the lateral plates and with the hypoblast. At a later period its connection with the mesoblast is severed, while the hypoblast becomes differentiated as a continuous layer below it.

As to the hypoblastic origin of the notochord, they are again in complete accord with Gerlach, but differ from him in admitting that the notochord is continuous posteriorly with the axial tissue of the primitive streak, and also at first continuous with the lateral plates of mesoblast.

The authors add:—"The account we have given of the formation of the mesoblast may appear to the reader somewhat fantastic, and on that account not very credible. We believe, however, that if the view which has been elsewhere urged by one of us, that the primitive streak is the homologue of the blastopore of the lower vertebrates, is accepted, the features we have described receive an adequate explanation.

"The growth outwards of part of the mesoblast from the axial line of the primitive streak is a repetition of the well-known growth from the lips of the blastopore. It might have been anticipated that all the layers would fuse along the line of the primitive streak, and that the hypoblast as well as part of the mesoblast would grow out from it. There is, however, clearly a precocious formation of the hypoblast; but the formation of the mesoblast of the primitive streak, partly from the epiblast and partly from the hypoblast, is satisfactorily explained by regarding the whole structure as the blastopore. The two parts of the mesoblast subsequently become indistinguishable, and their difference in origin is, on the above view, to be regarded as simply due to a difference of position, and not as having a deeper significance.

"The differentiation of the later plates of mesoblast of the trunk directly from the hypoblast is again a fundamental feature of vertebrate embryology, occurring in all types from *Amphioxus* upwards, the meaning of which has been fully dealt with in the 'Treatise on Comparative Embryology' by one of us. Lastly, the formation of the notochord from the hypoblast is the typical vertebrate mode of formation of this organ, while the fusion of the layers at the front end of the primitive streak is the universal fusion of the layers at the dorsal lip of the blastopore, which is so well known in the lower vertebrate types."

Development of Lepidosteus.*—Prof. F. M. Balfour and Mr. W. N. Parker state that the ovum is invested by a thick inner membrane, and an outer layer of pyriform bodies, which would seem to be metamorphosed follicular epithelial cells; the segmentation is complete, though very unequal; here, as in the division of the epiblast into an epidermic and a nervous stratum, and in the formation of the walls of the brain, &c., from a solid "medullary keel," we have resemblance to the Teleostei; the same is true of the archinephric duct, which is developed from a hollow ridge of the somatic mesoblast, and, by constriction, gives rise to a duct with an anterior pore, leading into the body-cavity. The olfactory sacs arise as invaginations of the nervous layer of the epiblast, the superficial epidermic layer becoming ruptured to allow of communication with the exterior; the primitive single opening divides to give rise to the double opening of the adult. The suctorial disk of the larva is shown to be formed of papillæ composed of elongated epidermic cells, which probably pour out a viscid secretion. The pronephric chambers remain in communication with the body-cavity by two richly ciliated canals; some of the mesonephric tubes of the larva have peritoneal funnels. No traces of a hyoid gill were detected in any larvæ.

Spermatogenesis in Vertebrates and Annelids.†—A. Sabatier considers that the observations he has made on spermatogenesis in *Salmacina*, one of the Serpulidæ, throw great light on the process in Vertebrates.

The spermatospores, or mother-cells, which line the walls of the spermatic sacs, are, by multiplication of the nuclei and by budding, covered with claviform pedunculated cells, the *protospermoblasts*. Each of these enlarge, detach themselves from the group, and in their turn present a new multiplication of nuclei with superficial budding. Hence arises a second generation of spermatoblasts, the *deutospermoblasts*, which are ultimately transformed into spermatozoïds, the nuclei of the former forming the heads of the latter, while the body and tail are filaments of the protoplasm.

This double generation appears to the author to explain, simply and rationally, the complicated and very extraordinary process attributed by Balbiani to the process of spermatogenesis in vertebrates. The cellular groups composed of a large round central cell (female

* Proc. Roy. Soc., xxxiii. (1881) pp. 112–9.
† Comptes Rendus, xciv. (1882) pp. 172–3.

element), and small peripheral smooth cells applied to their surface (male element), which he considered to be primordial ovules surrounded with epithelial cells, and consequently as young male Graafian follicles, are the primitive spermatospore covered with the protospermoblasts, and the group of daughter-cells, which, according to Balbiani, are produced by budding of the epithelial cells, are in fact the deutospermoblasts.

There is therefore no necessity to imagine the intervention of a conjugation of elements of supposed different sexuality, and a fecundation of which there is no serious proof.

Further researches on the Plagiostomi (*Raja* and *Scyllium*) and Amphibia (*Rana*, *Hyla*, and *Bufo*), have confirmed the author's views. He is also satisfied that the oval refracting bodies observed on the sides of the bundles of spermatozoïds before maturity (the "problematical bodies" of Semper to which Balbiani attributed a very important function as the female fecundating element) are simply nuclei of deutospermoblasts which have not undergone division.

Cell-structure.*—The first portion of W. Flemming's third contribution to this subject deals with the ovum of the Echinodermata. He finds that in the ripe ovarian ovum of the Echinoidea (and it may be supposed in others also), there is a radiate arrangement of the protoplasm of the eggs, which persists and even becomes more distinct during fertilization; this radiation is not to be confused with the formation of the asters. There exists a sperm-nucleus which fuses with the ovarian nucleus; the sperm-nucleus is formed by the anterior portion of the head of the spermatozoon, or that part to which Flemming gives the name of the chromatic substance. The doctrine of Fol, that the protoplasm of the male element alone enters into union, cannot be held; what is rather true is that the chromatin (or nuclear body), both of the male and of the female nucleus, enters into the formation of the cleavage-nucleus. The division of this last, formed, as we have seen, by copulation, differs in no essential respect from the karyokinetic (indirect) division of other cell-nuclei. All the filamentar forms, with unimportant changes in certain phases, are exactly similar to those already noted when describing the division of the nuclei of the cells of tissue. The mother-star of the karyokinetic figure has not the same centre as the radial arrangement of the ovarian protoplasm. The radial forms of the daughter-nuclei have, however, the same centre; but this is true also of other than ovarian cells.

The author insists on the fact that most ova are very unsuitable objects for the study of dividing nuclei; the observations by him on this subject were carried out at Naples on *Sphærechinus brevispinosus*, *Echinus miliaris*, and *Toxopneustes lividus*.

Dealing with the phenomena of nucleus-division in the walls of the embryo-sac of *Lilium* and other plants, Flemming directs attention to the results of Strasburger, from which his own differ considerably. He finds that in all nuclear figures there are many more chromatic filaments than that author has represented, and that these do not

* Arch. Mikr. Anat., xx. (1881) pp. 1–87 (4 pls.).

present considerable enlargements or diminutions in size, but that they are either all of the same thickness, or only here and there present variations, and these of the very slightest character. There is no compact plate in the equatorial plane, but only closely packed coils; in this plane there is frequently to be observed a clear medulla, the presence of which appears to have escaped the notice of Strasburger. After carrying these criticisms further, attention is drawn to many points in which there is a resemblance between the cells of the tissues of animals and plants.

Further studies have been made on karyokinesis and the structure of the nuclei. As to the latter, we may note that the author finds that what he has called the "intermediate substance" of the nucleus contains, after treatment with reagents, and probably also during life, a fine continuation of the nuclear network. The fine granulation which may be seen in the intermediate substance of the nucleus with less powerful lenses, and which was formerly thought to be due to coagulation in a homogeneous mass, is to be referred to this fine framework; the bars, so to speak, of which it is made up are the direct continuation of the coarser, and are chromatic. It is, perhaps, to the presence of these that we have to refer the possibility of colouring the intermediate substance of the nucleus. The nuclear envelope, so far as it is capable of being coloured, consists of small peripheral enlargements of these bars, and is formed of the same substance as they are. The question whether there is an achromatic membrane enclosing the nucleus cannot yet be decided.

After giving some account of the polar corpuscles, Flemming points out that the angles of the filamentar loops, which go to form the stellate chromatic figure, are often distinctly in contact with one of the achromatic fibres; the paleness and fineness of the latter are so extreme that never more than a part of them has ever yet been detected; from what he has seen, however, he concludes that this touching of a chromatic loop with an achromatic filament corresponds to the natural position. It would follow, therefore, that the angle of the loop has been attracted by the filament, and that later on the loops, when the mother-figure divides, would become arranged in two groups.

In some examples of the star or circlet-forms the chromatic filamentar loops lie so freely that they can be counted, with the aid of oil-immersion objectives and Abbe's illuminating apparatus. In the epithelial cells of the buccal and branchial epithelium of the larvæ of salamanders four-and-twenty loops were in three cases quite distinctly made out. In other cases from 17 to 22 were less distinctly seen, and the possibility is that in these cases there were really 24 filaments also.

Dealing lastly with some observations on cell-division in Man, it is stated that in the epithelium of the cornea of an adult subject, the lowermost layers exhibited rare and scattered cell-divisions, but here again, just as in *Salamandra maculata*, the chromatic figures were detected, but the achromatic could not be seen, so small was the object. In the blood of a leucocythæmic patient cell-division with

kinetic figures was seen; the blood was excessively rich in colourless cells, and had a yellowish-white colour; of several thousand cells, it was computed that only one per thousand exhibited karyokinesis. From this it may be concluded either that in leucocythæmia the colourless cells multiply by direct constriction of the nucleus, or that indirect cell-division chiefly occurs in the spleen and osseous medulla, so that it is only rarely that cells are caught dividing in the blood itself. Dealing with some deviations from the ordinary mode of cell-division in sarcoma and carcinoma, the author takes the opportunity of insisting on the fact that as an ordinary rule, nuclear division is on the same type in man as in the Amphibia.

Summing up the results at which he has here arrived, Flemming finds that in different objects—ovarian cells, plant-cells, and human epithelia—he has again been able to demonstrate that the physical processes and the corresponding mechanics of kinetic nucleus-division is, or appears to be, everywhere essentially the same; at any rate, there is no reasonable ground for doubting this uniformity. He then passes in detailed review the doctrines of Strasburger, a résumé of which it is impossible to give here. The author states that he sees as yet no ground for doubting that the nucleus is a division-organ for the cell, whether or no it has other functions in addition. This view is the only one which explains the general presence of the nucleus and the complicated kinetic processes of division. The phenomena observed in the nucleus may lead us some day to a true physiology of cell-division, and everything which bears, howsoever slightly, on this point, appears to be of much more importance than any merely morphological facts.

In using the term "homology of the processes," no reference has been imagined to phylogenetic considerations, and if serious objection be taken to its use, we have only to replace it by "homotypy." The questions raised in this connection by Strasburger have no importance for the histologist.

Theory of Amœboid Movements.*—Mr. J. B. Haycraft endeavours to account for the throwing out and subsequent retraction of the pseudopodia (of white blood-corpuscles and unicellular organisms), "pointing out, it may be, but one factor, but that a probable one."

The author's suggestion is that in those corpuscles which exhibit amœboid movements, they are due to contractions of the stroma or network of the protoplasm, which contracts at every part except where the pseudopodium springs from, forcing the interstromal matter at this point through the aperture left patent.

"This accords well with the fact that the pseudopodia seem actually to be projected always as radii from the cell, and that they are of a very hyaline nature. The difficulty is to comprehend the forces engaged in their retraction. There are probably at least three:—(1) the relaxation of the stroma; (2) the viscosity of the substance; and (3) surface tension, in virtue of which a body tends to assume the spherical shape.

* Proc. Roy. Soc. Edin., xi. (1881) pp. 29–33.

Now this may be very well theoretically, but are these three factors equal to the occasion? is the question before us. I have imitated the structure of the *Amœba* in the following way:—

An indiarubber ball is pierced by two or three holes near together; these should be about the diameter of a common darning-needle. A larger aperture (half an inch across) is then made in the ball, but opposite to the smaller holes, and the ball half filled with white of egg (unboiled) tinted with magenta. The ball represents the stroma, while white of egg takes the place of the interstromal matter. The ball is now dipped into a beaker of water to which sugar has been previously added until its specific gravity is equal to that of white of egg. Place a finger over the aperture through which the ball was filled, and press upon it with the other fingers of the same hand. Beautiful little magenta-stained pseudopodia will be projected from the small apertures into the sugar solution, and on relaxing the pressure, still keeping the finger over the aperture above, the pseudopodia will be completely retracted. I have been able in this way to project them three or four inches, and afterwards they have been completely retracted.

One might use common water in place of sugar solution, but as the specific gravity of the white of egg is greater than that of the water, the pseudopodia, when they have been projected more than an inch or so, break off and fall to the bottom. The size of the aperture is also rather a nice point, for there is one size—roughly $\frac{1}{16}$ inch in diameter—which is best suited for white of egg, although any sized aperture will answer, though not so well. This no doubt varies with the fluid used; ordinary ink may be substituted for white of egg, and oil for the sugar solution."

The author cannot but believe that in the stroma the active cause for these movements is to be sought for, and, as far as he can see, the mode described above for its action is least in antagonism to known facts.

While, no doubt, many of the bulgings seen in the white corpuscle of the newt's blood are due to changes in shape of the whole cell, probably with slight local accumulation of interstromal matter, yet may it not be that many of those fine hyaline processes are but interstromal matter projected from the cell?

Distinctions between Organisms and Minerals.*—In 1878 G. Fournier, by mixing together certain inorganic salts, produced pseudo-organisms, which in form and structure might easily have been confounded with cryptogamic plants, and similar experiments have now been made by D. Monnier and C. Vogt, who describe them as follows:—

Figured elements presenting all the characteristics of form belonging to organic elements, such as cells, simple and with porous canals, tubes with sides, with septa, and with heterogeneous granular contents, may be produced artificially in an appropriate liquid by the joint action of two salts forming by double decom-

* Comptes Rendus, xciv. (1882) pp. 45–6.

position one insoluble salt or two such. The one of these salts must be dissolved in the liquid, whilst the other must be present in a solid form.

These forms of organic elements (cells, tubes, &c.), being produced either in a liquid of organic or semi-organic origin (such as the saccharate of lime), or an absolutely inorganic liquid (e. g. silicate of soda), there can be no longer any question of distinctive forms characterizing inorganic bodies on the one hand and organic on the other.

The formation of such pseudo-organic figured elements depends on the nature, the degree of viscosity, and the concentration of the liquids in which they are produced. Certain viscid liquids, such as solutions of gum arabic, or of zinc chloride, yield nothing of the kind.

The forms of these pseudo-organic products are constant with reference to the salt employed, and constant also as any crystalline form of minerals. This characteristic form is so well maintained that it may even serve for the detection in mixtures of a very minute proportion of a substance. This form may be employed as a means of analysis, as sensitive as spectral analysis, and to distinguish for instance the alkaline carbonates, sesqui-carbonates, and bi-carbonates from one another.

The form of the artificial pseudo-organic elements depends principally on the acid which enters into the composition of the solid salt. The sulphates and the phosphates in certain cases produce tubes, whilst the carbonates give rise to cells.

With some exceptions, such as copper, cadmium, zinc, and nickel sulphates, the pseudo-organic forms are only produced by means of substances which are found in real organisms. Thus the saccharate of lime produces organic forms, whilst those of strontia and baryta do not.

The artificial pseudo-organic elements are enveloped in true membranes possessing a high degree of dialysing power, and giving passage only to liquids. They have heterogeneous contents, and produce in their interior granulations arranged in a regular order. They are, therefore, both in form and constitution, absolutely similar to the figured elements of which organisms are constructed.

It is probable that the inorganic elements contained in organic protoplasm play a certain part in the constitution of the figured organic elements for the determination of the forms which those elements present.

It is suggested * that by these experiments one of the characters by which mere lifeless matter was till yesterday differentiated from the living organism is wiped out. There are no longer any distinctive forms by which we may distinguish the two great classes, and it is asked whether it is not very possible that such structures might be produced without human intention and interference, in what may be called an accidental manner? Might they not, considering the large proportion of silica which they contain, become preserved for ages, and continue to display pseudo-organic features? Suppose we find, in

* Journ. of Sci., iv. (1882) pp. 148-53.

a rock, certain structures exhibiting apparently organic cells, are they the remains of true organisms or of pseudo-organisms? This consideration, at least till it has been further studied, is not without its bearing upon such questions as the organic or mineral nature of the structures found in meteorites, and, e. g., of *Eozoon canadense*.

B. INVERTEBRATA.

"Symbiosis of Animals with Plants"—Chlorophyll-corpuscles and Amyloid Deposits of Spongilla and Hydra.*—Professor E. R. Lankester discusses this subject in an interesting article, with special reference to the recent views of K. Brandt † (endorsing those of Semper) that the green-coloured corpuscles found in the cells of *Spongilla fluviatilis* and *Hydra viridis* are not similar in nature to the chlorophyll-bodies of plants, but are parasitic or "symbiotic" unicellular algæ.

Whilst Professor Lankester considers that there is "very nearly sufficient ground" for accepting the existence of "symbiosis" so far as regards the "yellow cells" of Anthozoa and Radiolarians, yet he regards Semper and Brandt's extension of it to *Spongilla* and *Hydra* as not justified. It appears to him that the green-coloured corpuscles found in the latter case are clearly similar in nature to the chlorophyll-bodies of green plants, and that "there is no more reason to regard them as symbiotic algæ than there is to regard the green corpuscles in the leaf of a buttercup as such."

In the course of the discussion it is pointed out that the investigation of the claims of any given greenish-coloured pigment to be regarded as "chlorophyll" is by no means a simple matter. Supposing the pigment to be soluble in alcohol, we still have to ascertain which of Sorby's three groups (chlorophylls, xanthophylls, lichnoxanthines), are present, and which of each of the species distinguished by him within those groups.

In order to do this we have to rely on:—

1st. Variations in degree of solubility in such media as alcohol, ether, benzine, carbon bisulphide.

2nd. Absorption spectra of the series of solutions obtained.

3rd. Fluorescence and spectrum of the fluorescent light of such solutions.

4th. Reactions of the solutions with acids, alkalies, and oxidizing and reducing agents, which give rise to new compounds or change the spectra characteristically.

There are, however, two other categories of phenomena in relation to the chlorophyll-bodies of green plants which comprise data of a nature to assist us in judging of the similarity or dissimilarity of the green pigments of animals compared with that of the chlorophyll-bodies. There are, 5thly, the *physiological* activities associated with the chlorophyll-bodies of plants; and 6thly, the *morphological* features of these bodies.

* Quart. Journ. Micr. Sci., xxii. (1882) pp. 229-54 (1 pl.).
† See this Journal, *ante*, p. 241.

If we find in an organism physiological processes associated with the presence of a green pigment, which processes are identical with those associated with the presence of the green pigment occurring in the chlorophyll-bodies of plants, we have so far a certain amount of evidence in favour of the identity of the green pigment in the two cases. And again, if we find that the green pigment in an organism occurs in corpuscles which are morphologically similar to the chlorophyll-bodies of plants, we have so far evidence in favour of the identity of the green pigment in the two cases.

In the author's view there is only one animal—*Spongilla fluviatilis*—in which the presence of chlorophyll has been definitely established by chemical and spectroscopical investigation (Dr. Sorby). The full corroboration by physiological and morphological evidence is still wanting, although to Mr. Geddes' physiological researches on *Convoluta Schulzii* " some value must be ascribed." Similar physiological evidence in favour of the assimilation of the green pigment of *Hydra viridis* to that of green plants has also been obtained by Mr. J. E. Blomfield.

A full statement is given of the author's own observations with reference to the *form* under which the green pigment of *Spongilla* occurs, which confirm the spectroscopic evidence, and refute the view of Dr. Brandt that chlorophyll is never formed by animal organisms, but, when found in animal cells, is due to the presence of parasitic algæ. No cell-nucleus really exists in connection with the green corpuscles of *Spongilla* or *Hydra* as asserted by Brandt, nor does his important observation of the formation of starch in isolated chlorophyll-corpuscles tend in any way to prove that they are independent organisms but simply that a bit of protoplasm with its associated envelope or cap of green substance can retain its vital activity just as a piece of *Amœba* can. From Brandt's account of his experiments in infecting Infusoria with the supposed parasites of *Spongilla* and *Hydra*, it is at once apparent that they are *opposed* to and not in favour of the parasitic theory. The chlorophyll-corpuscles of *Spongilla* were digested or else ejected by the infected Infusoria. In other cases the chlorophyll-corpuscles of *Hydra* remained in the Infusorian's body *unchanged*. Had Brandt's view been confirmed, the green corpuscle ought to have multiplied in its new host, and even such evidence of a temporary manifestation of vitality after removal from the *Hydra* or *Spongilla* would not be at all conclusive to the effect that the chlorophyll-corpuscles are independent organisms, and not parts of the protoplasm of the cell in which they are normally found.

With regard to *Hydra*, a very strong argument against the supposed parasitism is found in the fact noticed by Kleinenberg that minute angular fragments of a given colour are often present together with the normal corpuscles. These present no difficulty if the corpuscles are regarded as products of the animal's cell-protoplasm, but are inexplicable on the parasite theory.

The final conclusion is that a careful study of the chlorophyll-corpuscles of *Spongilla* and *Hydra* reveals their correspondence with

the known structure of the chlorophyll-bodies of plants; and those who, like Semper and Brandt, have supposed them to be parasites, have been misled, first by an imperfect acquaintance with the character of chlorophyll-bodies in general and of these in particular, and secondly by the plausible but delusive analogy presented by the "yellow-cells" of Radiolarians and of Anthozoa.

There is a field for experimental inquiry in regard to animal chlorophyll, as it is very important to know whether it serves the same purpose as in the plant, and if so, whether we may not be able to get indications as to the disputed function of the green pigment which plants are unable to furnish.

Palæontological Significance of the Tracks of Different Invertebrates.—Herr Nathorst has instituted some very interesting and important experiments in explanation of the traces in rock formations of various organisms. As we have not the original, we give the following report on it by T. Fuchs: *—"In the sandstone and marl of all formations there are often found, in greater or less quantities, certain marks and imprints the nature of which has been hitherto problematical, as they have been interpreted either as algæ or animals, or simply regarded as inexplicable. Such are the *Fucoides Harlani* from the Cambrian of America, the *Nemertites* of the culm-shales, the '*Zopfplatten*' (a term applied to flattened hair-like impressions) of the Jura, the endless varieties of different 'hieroglyphs' of the Flysch formation, as well as the various impressions described as *Prolichnites*, *Eophyton*, *Spirophyton*, *Taonurus*, &c.

Nathorst has hit upon the happy idea of solving this problem by allowing different animals to crawl or run over soft mud, and then studying the tracks thus made by them. Although he has only experimented with about 40 marine animals, and a few insects, larvæ, and earth-worms, still the result of his researches was truly astonishing, as he succeeded not only in artificially representing the finest *Nemertites*, *Harlaniæ*, '*Zopfplatten*,' *Eophyton*, &c., but he made the most unexpected discovery, that by far the greater number of the so-called 'Fucoids' (e. g. *Buthotrephis*, *Chondrites bollensis*, *Ch. hechingensis*, and even the Fucoids of the Flysch, are nothing else than branched worm-tubes. However unexpected this discovery may be, there can hardly exist a doubt as to its accuracy after the experiments and evidence of the author. On taking several worms of the species *Goniada* and *Glycerea*, which are found in great numbers on the coasts of Norway, and allowing them to crawl over soft mud, he observed, to his astonishment, that they invariably made a branched track, like the twigs of a tree. They first advance a short distance, then go back a little over the track, and turn away on one side, thus producing a branch; this they repeat from different points and on different sides, finally returning to the point whence they started, and make a second main track in another direction, which they

* Handl. K. Svenska Vetens. Akad., xviii. (1881). Verh. k. k. Geol. Reichsanst., 1881, p. 346. See Naturforscher, xv. (1882) pp. 113-16.

branch in the same manner as before. In this way a whole tree is produced.

This manœuvre is carried out by the worms, not merely on the surface, but they also burrow into the mud and from a given point produce a system of branched tubes, which being lined with a slimy coating, acquire a certain firmness. If a thin mixture of plaster of Paris be carefully poured over this perforated mud or clay, it will enter the tubes, and by carefully washing off the mud after the plaster is fixed, the cast of the tubes will bear the appearance of a delicate tree.

If it is assumed that a bed of mud or clay can be thus burrowed by *Goniada* and *Glycerea*, and that the burrows can be filled with a soft substance, there will consequently be seen in a section of this bed, branched impressions which have the appearance of Algæ, but which are, in reality, branched tubes made by worms.

With regard to the fossil *Chondrites*, especially *Chondrites bollensis* and *hechingensis*, and the Chondrites of the Flysch, it had already occurred to many that these so-called Fucoids did not lie, like other fossil plants, pressed flat between the strata, but that they were found much more nearly in their proper form in the beds of marl, as though they had grown through them. It was also remarkable that they were never found in a carbonaceous condition, but invariably in marl. Heer has also drawn attention to the fact that these 'Fucoids' occur in all formations, from the lias to the upper eocene, in almost identical forms, while in existing seas hardly any analogous specimens can be found. This fact was the more inexplicable when it was considered that, for example, the algæ of the Paris limestone, or the Flysch of Monte Bolca bore the closest resemblance to the existing forms of algæ, so that at the period of the eocene formation, types of algæ existed analogous with the present.

There were also other difficulties. Algæ always grow only in small depths on a firm foundation, and never in mud. Now the localities in which the so-called Fucoids are found in the greatest quantities are manifestly formations of mud, and deposited in a deep sea.*

All these difficulties at once vanish when it is known that these so-called 'Fucoids' of the Flysch are not algæ, but only the tracks of worms; the peculiarity of their origin is then no longer incomprehensible. Worms are to be found in the sea at a great depth, and like especially slime and sand; and it thus becomes evident that such perishable impressions as those made by worms are more lasting in the deep sea than in the formations nearer the shore, because they are not so easily effaced or disturbed.

Among other marks observed by Nathorst, the following may be mentioned:—*Corophium longicorne* (a Crustacean) makes an impression

* It might of course be assumed that algæ, like *Sargassum*, torn from the place where they grew, and driven out to sea, finally sink down into the mud of the deep sea, but even with such an hypothesis these Algæ would always appear unusual and accidental, while the Chondrites in the Flysch have a constant characteristic.

which corresponds exactly with the '*Zopfen*' of the so-called '*Zopfplatten*'; *Idothea baltica* forms Prolichnites; a Planarian makes a flat, ribbon-like track; *Montacuta* makes dentated impressions, which closely resemble Graptolithes; an unknown animal makes a regular, zigzag, serpentine mark; a piece of an alga drawn over mud produced a streaked mark which corresponded exactly with what is described as *Eophyton*, and which has hitherto been considered a plant. Similar impressions were made by the tentacles of Medusæ. Drops of water falling upon mud covered with a thin stratum of water produced remarkable, regular, wheel-shaped figures, which at a distance recall Medusæ. An earthworm made an impression very similar to what is usually described as *Spirophyton*, and hitherto considered an alga. This was produced in the following manner:—In creeping over the wet mud, the worm suddenly came to a stand; and while its hinder part remained motionless, the anterior was stretched out, while it at the same time bent itself so much to the side that its head was brought close to the other extremity of the body. After the front part had thus been stretched to its fullest extent, it was suddenly drawn back again, without, however, altering the position of the hinder part and the head.

A complete review is also given of the marks of animals found in the Swedish rocks, and a catalogue of 129 publications in which these marks are described and illustrated. At the end of the list is a work by Saporta and Marion, which appeared about the same time as Nathorst's, with the title, 'L'évolution du règne végétale, les Cryptogames.' In this the authors endeavour to explain, according to the Darwinian theory, the gradual evolution of plants from the earliest stages, through the series of geological formations to the present day. Unfortunately" (it is said), "the greater number of fossil remains regarded in this book as plants are in reality the marks of worms."*

Nathorst has also published a second interesting paper † on the origin of particular marks, which Herr Fuchs abstracts as follows:—

"Some time ago peculiar unknown bodies were found in the Cambrian strata of Lugnas in Sweden, which were described by Torell and Linnarson under the names of *Spatangopsis costata* and *Astylospongia radiata*. These bodies are in the form of 4–5 rayed stars or 4–5 cornered pyramids, which either lie free in the mud, or with the under surface adhering to the rocks, or form only an impression on a slab. Between the rays and corners are occasionally to be seen crescent-shaped projections. When Nathorst was at Oeresund in 1880, it happened that a large number of *Aureliæ* were thrown on the shore. The animals all lay with the mouth downwards, and when he took one up he observed that it had sunk in the soft ground by its own weight, and that its gastrovascular system had made a star-like impression, showing the most striking resemblance to the so-called *Spatangopsis*. He then followed up the matter further, partly by making impressions of various *Medusæ*, and partly by filling up their gastrovascular system with plaster, and so obtained a

* A rather too sweeping assertion.—Ed.

† Handl. K. Svenska Vetens. Akad., xix. (1882).

cast. The preparations thus made corresponded so exactly in every detail with the problematical bodies from the Cambrian, that no doubt could exist as to their identity. The stars and pyramids are casts of the gastrovascular systems of the Medusæ, the rays of the stars and the angles of the pyramids correspond with the arms, and the crescent-shaped projections occasionally occurring between the angles are casts of the genital cavities. The impressions on the slabs of rock are produced by Medusæ thrown on the shore, and which, sinking more or less into the soft ground by their own weight, make a more or less complete impression of the body-cavity. The bodies lying free in the clay were probably produced by Medusæ which lay on their backs, their gastrovascular system becoming filled up with sand or mud. There are some Medusæ which do not swim, but sink into the mud on their backs, and lie still watching for their prey.

The fact that the number of rays in these fossils varies from 4 to 5 is not an objection to their medusoid nature because in the present day individuals are found with 5, 6 or 9 rays. Certainly this deviation from the normal number appears more frequently in the Cambrian Medusæ than in the existing species.

The impression of the disk and traces of the tentacles are still distinctly seen round a four-rayed star on a rock from Lugnas. Many slabs are covered with thick, spiral, vermicular bodies, which Nathorst considers to be arms torn from Medusæ. Certain thread-like marks on sandstone were supposed by him to be made by swimming Medusæ that grazed the ground with their tentacles. He was also of opinion that the so-called Eophytes, which occur in great quantities in the same strata as the Medusæ fossils, were without doubt produced by creeping Medusæ.

The following species of Medusæ from Lugnas have been distinguished by him: (1) *Medusites radiatus* Linnars. sp.; (2) *Medusites favosus* n. sp.; (3) *Medusites Lindströmi* Linnars. sp.

Hitherto Medusæ were only recognized with certainty in the Solenhofen slate, and the discovery of Nathorst is therefore of great interest. It is especially interesting also because these Medusæ occur in the deepest strata that have ever produced fossils, so that they must be reckoned as amongst the oldest animals whose tracks are known to us."

Lymph of Invertebrates.*—C. F. W. Krukenberg obtained 12–14 drops of pure lymph from a medium-sized *Hydrophilus piceus*; he finds that the lymph varies remarkably in different individuals, the colour being different even when the specimens have lived under the same conditions. The coagulation which is spontaneously formed in it is, compared with that of the hæmolymph of Mollusca and Crustacea, of a more membranous nature, and not gelatinous; the lymph undergoes coagulation at a comparatively low temperature. The melanotic change of colour presents remarkable individual variations, which lead to the belief that the body which blackens immediately on exposure to the air is in certain cases preformed in the circulating lymph. The

* Verh. Nat. Med. Ver. Heidelberg, iii. (1881).

hæmolymph of *Planorbis*, like that of Vermes, does not coagulate spontaneously; the coagulation temperature is very different to that of the hæmolymph of the Gastropoda, for while this coagulates at 60° C., a small amount of fluid can be filtered from the former at 64° C. The coloration of the fluid of *Planorbis* is solely due to its hæmoglobin, but the intensity of the colour is never so marked as it is generally in the Mammalia.

Mollusca.

Development of the Cephalopoda.*— Dr. M. Ussow, in describing the formation of the germinal glands, points out that the unpaired ovary is a conical sac occupying the lower part of the trunk, and often, when mature, of considerable size. The ripe ova fall into the cœlom, and thence by the ciliated epithelium are carried to the oviduct. By the antiperistaltic movements of these latter, they are conveyed into the respiratory cavity, and thence by the contraction of the funnel to the exterior. The Graafian follicles are so arranged that the central portion of the ovary is occupied with the younger or with the primordial ova. Each follicle has a separate theca, which is well provided with blood-vessels coming from the genital arteries. The first rudiments of the germinal glands appear during the periods of embryonic development, the small group of rounded mesodermal cells which appear in the third developmental period near the narrow end of the mantle and behind the systemic hearts, being, undoubtedly, converted into ovarian glands or sperm-glands. Further development, and the formation of the efferent ducts appear to be post-embryonic. During these changes the mesodermal cells become converted into a number of racemose Graafian follicles, the walls of which are formed by the thin theca, and by a uni- or bilaminate *membrana granulosa*. A primordial ovum and the formative yolk are nothing more than a differentiated and greatly developed epithelial cell of the ovary. As the cell grows the Graafian follicles increase in size; folds then appear owing to the development of the *granulosa-cells*, their glandular inner surface increases, and secretes the nutrient fluids. The chorion is not formed till the secretion of the yolk is completed, and when it is formed there appears the micropyle; the chorion is elastic and transparent. Beneath it in the mature egg there is an inconsiderable quantity of fluid, which coagulates on heating, and within this there is the formative yolk, formed of a finely granular protoplasm and investing the less fluid nutrient yolk.

The first developmental period extends from the commencement of segmentation to the first appearance of the rudiments of the organs; there appears to be a striking similarity in the phenomena exhibited by different members of the group. At first all the cleavage-cells appear at one pole of the egg, the grooves extending from the central portion of the formative yolk outwards; the nutrient yolk is regarded by the author, in opposition to Prof. Lankester, as playing a merely passive part. Cleavage is at first superficial and only gradually extends to the more deeply lying parts; in *Argonauta argo* there was

* Arch. de Biol., ii. (1881) pp. 553–635 (2 pls.).

an interval of about one or two hours between fertilization and the appearance of the first two segmentation-spheres; in the other forms from 5–8 hours. After describing the process of segmentation in full, and discussing the results of earlier observers, Dr. Ussow passes to the next step, in which the blastoderm, &c., are developed. In the germinal disk it is possible to distinguish (1) the central portion, (2) the median portion, or *area opaca*, more or less ring-shaped in form, and (3) the lower protoplasmic portion, not yet differentiated into cells and continued as far as the lower pole of the egg. The central portion is formed by a single layer and consists of small, polygonal cells derived from the division of the six primary and two secondary cleavage spheres. In the fresh condition the finely granular protoplasm and the sharply contoured nuclei are quite transparent. The cells are almost all of the same size (0·016 mm.), the peripheral ones being alone somewhat larger. At first flattened, they gradually become cylindrical; and frequently alter in form by dividing longitudinally. The cells of the *area opaca* are longer, unequal in size, and polygonal in form; there are only two or three concentric rows; they owe their origin to the multiplication of those cleavage-cells which had been separated off by the development of the equatorial groove. They are dark in appearance, owing to the consistency of their protoplasm, and the thickness of the layer. The broadest and lower portion consists at one time of 32 segments, which are frequently arranged in pairs; as there is not a single large cleavage-cell, but 2–6 cells at the thickened apex of each segment, the edge of the germinal disk is irregular and villous owing to the projecting angles of the cells; between each pair of segments there is a clear intermediate space, filled up by an extremely thin layer of the formative yolk; this disappears as the blastodermic cells multiply. A little later (36th hour) there appear the rounded cells of the mesoderm; these arise from the cells of the median portion, which undergo transverse division; each of the cells so formed is rounded, and gradually takes on a cylindrical form. As soon as these cells appear the process of division begins to affect all the cells of these parts of the germinal disk, and is effected either transversely or longitudinally. Three or four successive rows of the larger blastoderm-cells, forming the median portion, divide longitudinally as soon as they have divided transversely; this, of course, increases the breadth of the median portion, which also becomes a thicker and therefore a darker ring; this ring surrounds the unilaminate and still transparent central portion. The other six days of the first developmental period are occupied by the multiplication of the cells of the peripheral portion of the germinal disk; the upper and median germinal layers extend over the surface of the nutrient yolk.

At the end of the second day of development the middle layers consist of several rows of cells; at the same time the ectodermal cells have continued to undergo transverse division, and have thus narrowed the central portion of the germinal disk. On the third day, separate groups of mesodermal cells make their way into the central portion, and towards the end of that day the upper limits of the mesoderm

are brought nearer to the superior pole of the egg. The layer which in all Cephalopods forms the wall of the outer yolk-sac, appears to the author to be simply formed of mesodermal cells, of which it would appear to be a direct continuation. The various facts which Dr. Ussow has observed lead him to think that in the Cephalopoda the mesoderm is not folded off from the ectoderm, but simply arises from the transverse division of the cells of that layer. Later, the diameter of the unilaminate central portion decreases considerably, while the median zone grows both centrifugally and centripetally. The cells of the ectoderm at first vary in form and size in different parts of the embryo; later on they all become short epithelial cells; but it is not till the ninth or tenth day that they are to be sharply distinguished from all the rest, and they are then cylindrical in form. The mesoderm grows in two directions, towards the central portion of the germ and the equator of the egg.

Contrary to the opinion of Kölliker and others, the author is convinced that all the Cephalopoda begin to develope from the dorsal side, and not from the hinder end of their body. Further observations are promised.

Development of the Oyster.*—Dr. R. Horst points out that the groove or depression described by Davaine and Lacaze-Duthiers is the invagination of the embryo, and that the dorsal depression regarded by Brooks as being the opening of the intestinal tube is really the shell-gland-invagination. These two inpushings, possessed by the oyster at one and the same stage, are almost equally well developed; later on the ventral side becomes a little pushed out so as to form a kind of foot. The abdominal cavity is formed by the separation of the ectoderm from the endoderm. The author confirms the doctrine of Salensky and Hatschek that the first rudiment of the shell is an unpaired formation, and he thinks that this is true of all Mollusca; Carbonate of lime is very early deposited in the shell. The white spat becomes black spat by the deposition of pigment at different points in the body of the larva. On the ventral face there is a button-like thickening of the ectoderm, which is probably the commencing rudiment of the otocyst.

Abortion of Reproductive Organs of Vitrina.†—F. d'A. Furtado, on examining seven specimens of *Vitrina* from the Azores, found that there was not the least trace of any reproductive organs, and Professor L. C. Miall confirms the observation as regards three other specimens sent to him. Abortion of the reproductive organs has been observed in animals infested by parasites, e. g. in stylopized bees, in *Lymnœa stagnalis* when attacked by Trematodes, and in female hermit-crabs attacked by Rhizocephala. The complete abortion of the parts, writes Professor Miall in the remarkable case described by Mr. Furtado, distinguishes it at once from the many cases of real or supposed functional defect met with in hybrids.

* Zool. Anzeig., v. (1882) pp. 160–2.
† Ann. and Mag. Nat. Hist., ix. (1882) pp. 397–9.

Morphology of the Amphineura.*—Dr. A. A. W. Hubrecht gives a convenient summary of the actual state of our knowledge of this class of animals, including a brief statement of what is "known, surmised, uncertain, or unknown," with respect to (*a*) integument, (*b*) nervous system, (*c*) intestine, (*d*) circulatory and respiratory apparatus, (*e*) reproductive and excretory organs.

Molluscoida.

New Synascidian.†—Dr. R. Drasche describes *Oxycorynia fascicularis*, which are found in cylindrical trunks of as much as 6 cm. in length; the colour of the colony is a dirty green, and the individuals which are only 10 mm. long have the branchial sac 6 mm. long. The rounded cloacal orifice is found at the uppermost tip of the sac. The animals are connected together by a very delicate and transparent tunic. The nearest ally would seem to be the *Chondrostachthys* of Macdonald.

Alternation of Generations in Doliolum.‡—Dr. Carl Grobben describes this phenomenon in detail, and amongst more general considerations, points out that nearly all animals which reproduce themselves by gemmation are of a fixed habit, the matter which is not used up in the work of locomotion being applied to the production and nutrition of buds; gemmation being inconveniently carried on by a free-swimming form, we must suppose that such free forms as do multiply thus are derived from ancestors that were fixed; we have a good example in the Siphonophora, and the same view may be applied to the Salpidæ.

The simplest mode of alternation of generations is, perhaps, to be seen in some compound Ascidians, where the individuals that arise from ova are sterile, while those that are developed from buds develope generative organs. This is a division of labour. In *Pyrosoma* the ovum gives rise to a cyathozooid, whence appear four ascidiozooids, and these multiply either by gemmation or by the formation of sexual elements. In the true Salpidæ the nurse developed from the egg gives rise to a chain of apparently very different forms which are altogether sexual in their mode of development. Here then there is a complete division of labour, and this is clearly due to their free life. Coming lastly to *Doliolum*, we find that here the larva developed from the egg, after losing its tail, gives rise to lateral and then to median buds, which latter provide the sexual forms. The differences between the zooids are considerable: the nurse has nine, the sexual form has only eight muscular bands; the former has an auditory organ which the latter is without; the first nurse of *Doliolum* has its stolon dorsal, and is therefore without a homologue in the rest of the Tunicata; in other words, it is a structure which has been independently developed, and in

* Quart. Journ. Micr. Sci., xxii. (1882) pp. 212–28 (11 figs.).
† Zool. Anzeig., v. (1882) pp. 162–3.
‡ Claus' Arbeit., iv. (1882) pp. 201–99 (5 pls.).

consequence of its appearance the ventral stolon of other Tunicates has been arrested in its development, and has become a rudimentary organ. The appearance of this new, dorsal, stolon is explained by the inherited capacity of the Doliolida to produce new structures by gemmation, and its supersession of the ventral one by the following hypothesis: the dorsal stolon is shown to be more embryonic than the ventral one by the fact of its only being formed of the three germinal layers, and not, like the latter, of six rudiments; we know that embryonic tissues have a much more considerable growth-energy than those that are more highly differentiated, and this advantage became more and more marked by the influence of heredity. The relations of the different generations is shown in the following diagrams, where a letter or a combination of letters marks a generation, A is a sexual, B an asexual generation, M the median, and L the lateral buds.

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 Synascidiæ.        Pyrosoma.        Salpa.     Doliolum.
     AB                AB              A            A
    /  \              /  \             |            |
   B    AB           B    AB           B            B\
  /    /  \         /    /  \          |            | \-L
AB   B    AB      AB   B    AB         A           [A]  M
                                                        |
                                                        A
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Dr. Grobben next passes to the phylogenetic history of alternation of generations in the Acalephæ; in the Hydroids, as Leuckart has shown, it is due to division of labour, in consequence of which only some individuals of the colony have produced generative products, and the Medusæ have been derived by natural selection from the free-swimming generative polyps. In the Acalephæ the phenomenon is likewise due to division of labour among the members of a colony. After a special reference to the studies of Professor Semper, the author passes to the Cestodes, where he does not discuss the question of the phylogenetic development, but merely raises the question whether we have here to deal with true alternation. He comes to the conclusion that it is not so, but that we have only a simple metamorphosis, the larva, vesicle, scolex, and strobila being one and the same individual in different stages of development. This is true of the common *Tænia*, but it does not apply to those cysticercoid forms in which several heads are developed, for each head represents a Tænia-individual with the power of developing proglottids. The history of the Trematoda is dealt with in the same manner, and it is pointed out that we have here to do not with alternation of generations, but with heterogony. The author comes to the conclusion that the so-called spores are ova capable of developing without fertilization; the generative products are either single cells (ova), or are derived from the germinal layers of the mother. In the one case we have sexual, and in the other asexual development; or, in other words, unisexual and bisexual generations appear alternately in the cycle.

Arthropoda.

a. Insecta.

Nervous System of the Larvæ of Diptera.*—E. Brandt has continued his researches on the nervous system of insects. † In the larvæ of the Leptidæ, Bibionidæ, Therevidæ, Xylophagidæ, and Dolichopodidæ (families whose nervous system has not hitherto been examined) there are thirteen ganglia, two cephalic, three thoracic, and eight abdominal. In the Leptidæ, the ganglia, instead of being joined by the simple commissures as in all other Diptera, are united by double nervous cords, as in the adult. In the next three families the two first thoracic ganglia are close to one another, while the third is further off. As the adult has only two thoracic ganglia, the first is evidently derived from the union of the first two of the larva. In the Dolichopodidæ the adult has no abdominal ganglia, and the second thoracic ganglion is therefore evidently derived from the fusion of the third of the larva with all the abdominal ganglia.

Several genera and species of families which have already been partially examined are also described, and the author finds that in the Tabanidæ the larvæ have seven ganglia, and not two only, as described by J. Künckel d'Herculais.

Occident Ants.‡—Dr. H. C. M'Cook publishes in a collected form his observations on the Honey Ants of the Garden of the Gods, which we have already dealt with in this Journal,§ and the Occident Ants of the American plains.

The occident ants build mounds of from less than half a foot to more than a foot in height, round which they make a circular "clearing" of grass and other vegetation, presumably by cutting it away after the manner of the agricultural ants of Texas, previously described by Dr. M'Cook. The mound is always covered with pebbles which have been removed in the process of excavating the underground chambers and galleries. Some of the pebbles so transported are ten times the weight of the ant, so that the labour performed would be paralleled by that of a man if he could carry half a ton up a staircase one-third of a mile high.

The ants do not begin their labour till eight or nine o'clock in the morning; so that, as Dr. M'Cook seems not unwilling to observe, "it might not be unmeet that those persons whose love of sleep during late morning hours has been disturbed by the familiar Scripture proverb, 'Go to the ant, thou sluggard; consider her ways, and be wise!' should return upon their mentors with the above-recorded facts, and cite this ant, who is indeed no sluggard, as being nevertheless fond of a morning nap." The day's work, or at any rate the day of outdoor work, begins by opening the gates which had been closed

* Comptes Rendus, xciv. (1882) pp. 982–5.

† See this Journal, i. (1881) pp. 234–5.

‡ M'Cook, H. C., 'The Honey Ants of the Garden of the Gods, and the Occident Ants of the American Plains.' 8vo, Philadelphia, 1882. Cf. Mr. G. J. Romanes in 'Nature,' xxv. (1882) pp. 405–7.

§ See this Journal, iii. (1880) pp. 242 and 775.

the previous evening. "The manner of opening the gate cannot be fully described, because the work is chiefly done within and behind the outer door of gravel. The mode would doubtless be correctly indicated by reversing the process of closing gates presently described. What I saw was, first, the appearance of the quivering pair of antennæ above one of the pebbles, followed quickly by the brown head and feet projected through the interstices or joints of the contingent gravel-stones. Then forth issues a single worker, who peeps to this side and that, and after compassing a little circuit round about the gate, or perhaps without further ceremony, seizes a pebble, bears it off, deposits it a few inches from the gate, and returns to repeat the task; she is followed sometimes cautiously and at intervals of ten, twenty, even thirty minutes, by a few other ants, who aid in clearing away the barricade, after which the general exit occurs. Again there is a rush of workers almost immediately after the first break, who usually spread over the hill, bristling around the gate, gradually widening the circles, and finally push out into the surrounding herbage. At first the exit hole is the size of a pea, perfectly round, and plainly shows that sand and soil have been used under the gravel to seal up the gate. The whole appeared to have been cemented, probably by the moisture of the night dew.

"The process of closing the gates is even more interesting to the observer than the opening, as the various steps are more under his notice. . . . At nest A the closing was chiefly from within. The workers pushed the sand from the inside outwards with their heads. A grass straw about an inch long was brought from the interior and pushed out until it lay across the gate as a stay for the filling material. Soil was here principally used for closing, a few pebbles being added." In another case, "when the gate was nearly closed a straggling minor came back from the commons and essayed entrance, wherein she failed. Several trials and failures succeeded, whereupon she commenced dragging the dirt from the opening. While thus engaged the major approached with a huge bit of gravel, which she deposited on her comrade with as much nonchalance as though she were one of the adjoining pebbles. At last the minor dug out a tiny hole through which she squeezed into the nest, and the major, who was deliberately approaching close behind her, carrying another pebble, immediately sealed up the opening. During this amusing episode the straggler made no effort to aid in the closing, being wholly intent on entering, and the gate-closer paid no attention to her whatever, beyond the first sudden and satisfactory antennal challenge. Each moved forward to her own duty with the undisturbed plasticity of a machine."

This "by-play" between the gate-closers and the late-returning foragers is not the exception but the rule; nevertheless it does not appear that the foragers ever so far miscalculate their time as to arrive after the gates are completely closed. When the gates are all but closed there is generally but a single ant engaged in the closing process from without; this ant slips in at the last moment, and the process is finally concluded from within. The gates are similarly

shut during the day-time if the weather seems to threaten a heavy rain-storm.

The ants, though provided with very formidable stings, are exceedingly mild and unwarlike. They present the same habits of "harvesting" as those which were previously known to occur in allied species of Florida and Texas.

γ. Arachnida.

Pycnogonida.*—After a review of what has been done by preceding naturalists, Dr. P. P. C. Hoek discusses the general form of the body; this is strictly bi-lateral, with a proboscis, four segments, and a rudimentary abdomen. The first segment is formed of one cephalic and of one thoracic ring; the proboscis ought not to be regarded as a head, it varies in form, and in length, and in the mode of its attachment to the cephalothoracic segments. The body may be slender or robust, the segmentation distinct or obscured; the abdomen is represented by a single joint, the length of which varies considerably; the surface of the body may be smooth or hairy, with or without tubercles or spines. There are never more than seven pairs of appendages, and when all are present three belong to the cephalothorax, and are known respectively as mandibles, palpi, and ovigerous legs; when the first are complete, they have three joints and a terminal pincer (*Pallenopsis*); in some cases (*Pycnogonum*) the mandibles altogether disappear in the adult state. The palps would appear to have primitively a number of joints, and this number varies even within the limits of a genus. There may be ten joints or as few as three, or the palps may disappear altogether. The females of all species, however, retain the ovigerous legs, and they are frequently also represented in the male. The nervous system consists, as usual, of a cerebrum, an œsophageal collar, and a ventral ganglionic chain; in the last there are four or five ganglia, *Phoxichilus* presenting an intermediate condition in having the first of its ventral ganglia small in size, and closely applied to the second; all are distinctly bilobate, the coalescence of the paired parts being complete. Concrescence never attains to the extent exhibited in the Brachyurous Crustacea, for even in *Ammœthea* it is possible, by the aid of reagents, to discover the connecting fibres. Nor, indeed, can external form be taken as giving any true idea of the extent of fusion, for *Pycnogonum*, in which there is an extreme condition of external " concentration," has the ganglia separated by some considerable distance. After a further discussion of allied points, the author states the eyes of the Pycnogonida have generally a very complex composition; ganglion-cells and rods can always be made out, but there would not appear to be any vitreous body; a lens is developed from the integument. The buccal orifice is triangular, and almost immediately dilates into a very large pharynx; at its end there is a constriction and a canal is developed, the length of which depends on that of the cephalic part of the cephalothoracic segment. The inner face of the cells lining

* Arch. Zool. Expér. et Gén., ix. (1881) pp. 445–542 (8 pls.).

this latter are invested in a delicate chitinous layer. The termination of the œsophagus is not abrupt; its three inner faces are prolonged towards the interior of the intestine, and give rise to three outgrowths which have all the appearance of special glands; tubular prolongations are, as is well known, connected with the intestine, but, though they no doubt are very important physiologically, the author has grave doubts as to their morphological significance.

Great difficulties seem to attend a satisfactory study of the circulatory system; the heart has three cavities, at the end of each of which there is a pair of orifices; it is probable that there is an aorta, although it has not yet been detected; as the author has mentioned in his 'Challenger' report, the dorsal surface of the heart is remarkable for having no muscular fibres.

The sexes may be easily distinguished, for, with rare exceptions, the males carry the fecundated ova. Contrary to what generally happens, the females have lost the primitive organization of the generative organs, while the males have been more conservative. For elaborated details on this, as on various other points, the author refers to his 'Challenger' report.*

Dr. Hoek would place the larvæ of Pycnogonids with the primary larvæ of Prof. Balfour. When we consider the zoological position and classification of the Pycnogonida, we are led to the conclusion that the doctrine of Semper, which regards them as Arachnida, has nothing to defend it; the only real point of resemblance between them lies in their having the same number of thoracic appendages; the similarity in the formation of the first pair of appendages, lately dwelt upon by Balfour, seems to the author to be of less significance than the fact that this organ is innervated by a nerve arising from the sub-œsophageal ganglion. Dr. Hoek thinks that the Pycnogonida must form a distinct class of the Arthropoda, comparable to the Crustacea, Insecta, &c.

Starting from the protonymph, or larval form common to *Ascorhynchus*, *Nymphon*, and *Pycnogonum*, and noting that in the two former there remain appendages, which become cephalic, while in the last they are during development obliterated, we have to consider *Pycnogonum* as the least ancient form. The doctrine suggested by the history of the metamorphosis is supported by a study of the nervous system; in the primitive condition the ventral part of the nervous system is represented by six ganglia, excluding the more or less rudimentary abdominal ganglia; of the six segments corresponding to these ganglia, four are thoracic; and two, in a more primitive condition, belong to the cephalic part. As the mandibles are innervated by the subœsophageal ganglion, we have three pairs of cephalic appendages, and this is what is permanently seen in *Ascorhynchus* and *Nymphon*. This possession of three cephalic appendages is, by various evidence, indicated as the primitive arrangement. *Nymphon* retains this most unchanged, but the number of the joints in its cephalic appendages and the structure of the genital organs forbid us to regard it as the most ancient form now living. A hypothetical

* See this Journal, i. (1881) p. 886.

primitive form or *Archipycnogonum* might be defined as a Pycnogonid of large size, with strong mandibles of three joints, and armed with a terminal claw, with long palpi of ten joints, with ovigerous legs of ten joints, the last four of which are spinous. The thoracic limbs have eight joints, and end in a claw, with two accessory claws. The descendants of this form are either delicate and have their limbs articulated at a considerable distance from one another, or they are robust and their limbs are set close to one another. Four natural families may be distinguished—Nymphonidæ, Ascorhynchidæ, Colossendeidæ, and Phoxichilidæ—by the aid of the differences exhibited in the structure of the appendages.

Spiders' Webs.*—Mr. R. J. Lecky, referring to the discussion at the January meeting of the Society (*ante*, pp. 142–3), writes :—"The geometric spider never spins a glutinous web ; the entire net is first made, beginning with the long stays (those alone suitable for optical purposes), then those at the circumference, next the radial threads, finishing the net with the spiral 'ratlins' (to use a nautical expression). When these are complete, the spinner begins at the 'ratlin' next to the exterior threads, and bedews them at regular intervals with the glutinous fluid, walking round and round until all is complete. This fluid spreads, in time, over the 'ratlins,' and so the thread appears as if spun in a glutinous state at the commencement."

δ. Crustacea.

Limulus a Crustacean.†—Dr. A. S. Packard, jun., who has also devoted much attention to this form, replies to Professor Lankester's paper on the Arachnid nature of *Limulus*,‡ maintaining that his conclusions are untenable. The criticism is not susceptible of abstract beyond the statement that Dr. Packard considers Professor Lankester has not correctly described the differences between the brain and the thoracic ganglionic mass of the scorpion and *Limulus*, that in the morphology of the brain the latter much more nearly approaches *Apus* and other Phyllopods than Arachnids, that four of the six segments described by Professor Lankester between the sixth abdominal segment and the spine are imaginary, as is also his view that the scattered simple eyes of the scorpion are really compound eyes, and some attempts to homologize parts of the scorpion with *Limulus*.

Segmental Organs in Isopoda.‡—Lereboulet in 1850 concluded that the Cloportides (Wood-lice) are allied to the Spiders, by the existence of special glands, secreting a silky substance ; but M. Huet considers that the facts he has observed would equally enable them to be referred to the Annelida or Myriapoda.

There are glandular organs not only in the caudal region of these animals, but in each of the seven segments of the body. They are absent from the head. They open in the superior portion of the

* Engl. Mech., xxxiv. (1882) p. 496.
† Ann. and Mag. Nat. Hist., ix. (1882) pp. 369–74.
‡ Comptes Rendus, xciv. (1882) pp. 810–11.

epimera, on each side, in a sieve-like aperture. In the tail, the reduced segments do not show the "sieves," the glands undergoing a sort of concentration, and all opening together in a slit pierced with holes arranged in linear series. This slit is on the external side of the external urostyle.

Each of these glands consists of cellular elements of comparatively gigantic dimensions, some of them measuring 0·2 mm. Each is composed of a knobbed, indented, lobate body, *always* enclosing two large, symmetrical, granular nuclei, close to one another. Each nucleus contains a nucleolus, also very granular. The nuclei are coloured red by carmine, and blue by iodized serum. Between them winds a sort of vestibule, from which issues a canal, filled with the secreted substance. The canals do not anastomose, but end separately in one of the sieve-like apertures, or in the slit of the urostyles.

This arrangement is found in the greater part of the terrestrial Isopoda, *Porcellio scaber*, *Oniscus murarius*, *Armadillo*, and *Ligia*. *Porcellio pictus* has only the caudal glands. It is not found in any aquatic Isopod, nor in *Ligia oceanica*, nor in *Anilocra*, *Idoteidæ*, or *Asellus aquaticus*.

Bopyridæ.*—R. Walz deals in order with the different parts of the organization of these parasitic Crustacea; the cuticle of the male is said to be thicker than that of the female; the larval stages do not differ from one another in any important particulars; the changes early undergone by the mouth-organs are noted; later on, the oral cone calls to mind the suctorial proboscis of some Siphonostomata. On the inner side of the base of the first five pair of legs are developed the brood-lamellæ, which acquire their full size when the female reaches maturity; they are always membranous, and their chitinous cuticle is produced, as a rule, into short denticles. Varying a good deal in form, they determine that of the brood-pouch. The gills are thin, lobate, rarely tubular appendages; they always decrease in size from before backwards, and are, as a rule, better developed in the female than in the male; in the latter, indeed, they are often nothing more than small protuberances on the abdomen which disappear with age. Each lamella consists of two folds with a very narrow intermediate space; from one wall there pass to the other supporting bars, which have a homogeneous clear appearance and are to be regarded as cuticular structures. The digestive apparatus exhibits special characters, in correspondence with the parasitic habits of its possessors; the fore-gut is first enlarged and then narrowed to a tube; it leads into a wider portion, and the whole is so arranged as to act as a suctorial pump. The fore-stomach is enlarged into a crop, and the inner wall of some forms is provided with a number of processes, by means of which there is a considerable increase of surface; but this peculiarly arranged crop is, it is curious to note, found only in the female and not in the male, where the corresponding region forms but a very slight enlargement. The mid-gut likewise is much smaller and narrower in the male than in the female. The salivary glands which have been described by Cornalia and Panceri,

* Claus' Arbeiten, iv. (1882) pp. 125–200 (4 pls.).

were not detected by the author. There is a pair of hepatic tubes which give rise to numerous enlargements and lobes, but no lateral enlargements are to be found in the males.

There is a well-developed heart in the form of a rounded oviform sac; in the irregularly developed female there is to be detected not only an asymmetry of form, but also of the position of the clefts. The wall of the aorta is formed by a clear transparent membrane, which never exhibits contractions; though efferent vessels are present, there are no afferent ones; a septum of connective tissue extends transversely below the enteron, just as in the Phronimida.

The nervous system has only been examined by Rathke, and by Cornalia and Panceri; in its morphological relations it differs completely from that of the other Isopoda; the brain is extremely reduced, as are all the parts connected therewith; in the third thoracic segment is a reduced unpaired ganglionic chain, formed by the shortening of the longitudinal commissures and the fusion of the ganglia; in this seven distinct elements may be made out. The peripheral nerve-trunks have a somewhat peculiar ganglionic relation. Those of the first go directly from their proper ganglion to the most anterior thoracic segment; the second pair passes below the third ganglion, and the next near the sixth, or, in other words, just in front of the termination of the nervous plate. The sensory organs are either a great deal reduced or have completely disappeared; in the young free-swimming male there are eye-spots and jointed, paired, antennæ; there is some question as to whether eyes can be said to exist in the female; at any rate true optic nerve-fibres are not always to be made out. The larvæ have reddish pigment-specks at the sides of the cephalic lobes, which are covered over by the base of the outermost pair of antennæ.

Not only do these parasites retain a separation of the sexes, but there is a well-marked sexual dimorphism; the ovaries are dorsally-placed tubes, not fused with one another, the appearance of which varies with the age and condition of the animal; at first they are straight, but they gradually become provided with a number of lateral saccular diverticula, which project into the thoracic segments; the orifices of these organs are found, as might be expected, on the inner side of the bases of the fifth pair of legs. The wall of the ovarian tube is a thin membrane, invested internally by an epithelium and completely transparent. The male organs have much the same general characters as the female; and the tube functions both as germinal gland and receptacle for the sperm; the spermatozoa are very small granules, immense numbers of which are collected into one mass. No formation of spermatophores, or any copulatory organs have been detected.

After referring to the musculature and the connective tissue, the author passes to the second part of his essay, where he deals with the classification of the Bopyridæ: owing to the small number of species it is not necessary to form any subfamilies; the difficulties of definition lie in the fact that the form of the body, the number of antennary joints, and the arrangement of the gills differ so much in the two sexes.

Vermes.

Peculiar mode of Copulation in Marine Dendrocœla.*—Claparède has already shown that in the genus *Thysanozoon* there are two penes and two male genital orifices, but only one orifice in the female. This observation has not only been confirmed by A. Lang, but much extended; he having found at Naples forms with nine or even fifteen penes. It is obvious that these could hardly have been intended to be introduced into the single vagina. The true signification of the contrivance was elucidated by the observation of the copulatory process in several species of *Proceros*—the penis was thrust indiscriminately into the body of the female, and through the wound thus formed the semen flowed into the oviduct which is distributed throughout the body. The female organ therefore serves only as an exit for the eggs.

Classification of the Nematohelminthes.†—Dr. L. Orley proposes to establish three suborders, to which he would give the names of Nematentozoa, Rhabditiformæ, and Anguillulidæ; the last are fitted for a free life, and are characterized therefore by the presence of circumoral bristles, lateral circular markings, and a caudal sucker; the Rhabditiformæ are intermediate, for, while they lack the characters just mentioned, they resemble the free-living and differ from the parasitic Nematentozoa in having a thin cuticle, and a single straight tube, as well as in the fact that their nervous system is either entirely absent, or consists only of a few fibres. So, again, while all Nematoids have free larvæ, those of the parasitic group perish unless they enter a host; the Anguillulidæ do not so enter, but develope in mould or water, while the Rhabditidæ may or may not enter into hosts. There is an arrangement of the genera, with short diagnoses, and two new species of *Filaria*, *F. spiralis* and *F. ecaudata*, are described.

Relations of the Platyhelminthes.‡—Dr. A. Lang gives an account of the results to which he has been chiefly led by his study of *Gunda segmentata*.§ Considering first of all the Polyclades as creeping Ctenophores, he points out that, in his opinion, the *Cœloplana* of Kowalevsky is not intermediate between the Ctenophora and Planaria, but is a true creeping Ctenophore; this form is remarkable for being flattened, for having the ctenophoral plates absent, and for a complete investment of cilia. The fact that external conditions can produce such great changes prevents us from giving any importance to such characters as these, when we compare the two groups. To most of the internal points of resemblance between them attention has already been directed; but with regard to the development, we may note that Selenka has lately pointed out the striking similarity he has found in the earlier stages; and the observations of Lang are confirmatory of the fact that the embryo of the Polyclades is at first radial, and that it is only later that it becomes bilaterally symmetrical.

* Arch. Sci. Phys. et Nat., vi. (1881) p. 308.
† Ann. and Mag. Nat. Hist., ix. (1882) pp. 301–18.
‡ Arch. de Biol., ii. pp. 533–52.
§ See this Journal, *ante*, p. 197.

It is pointed out that *G. segmentata* presents many features of striking resemblance to certain Hirudinea, and especially the *Rhyncobdellidæ*; the pharynx, like that of the Triclades, is contained in a special cavity; the intestine has always a number of paired diverticula, the number of which is constant for a given species. The two last are always longer than the others, and often have, on their outer side, secondary outgrowths. These may be compared to the lateral and posterior branches of the intestine of the Triclades. The terminal intestine, the posterior dorsal anus, and the large sucker are to be regarded as formations special to the Hirudinea.

There is likewise a considerable resemblance as regards the excretory system, but the collecting organ of the Hirudinea is, again, a new formation; in the adult leech there is no connection, as we know, between the excretory system and the enteric diverticula, but in the embryos of *Clepsine* there is evidence that this system is developed from the epithelium of these diverticula. Striking resemblances are also to be seen in the generative system. The ventral ganglionic chain of the Hirudinea does not appear to be so very different, if we suppose that it is comparable to the two longitudinal nerve-trunks of *Gunda* connected at segmental intervals by simple commissures.

The musculature of the Hirudinea is mesenchymatous; the unicellular muscular fibres consist of an axial substance with a nucleus and a contractile sheath, just as in *Gunda* there is a dorsal musculature consisting of an external layer of transverse muscles, and an internal one of longitudinal fibres. In addition, there are dorso-ventral muscles which cannot be distinguished from the muscular dissepiments of *Gunda*, and, just as in that form, there is no enteric muscular layer. The body-cavity of the Hirudinea is not an enterocœle, but a schizocœle, formed by the vascular and lymphatic systems which are in communication with one another, and are developed, as Prof. Lankester has shown, by the liquefaction of the parenchymatous cells of the mesenchyma. Were the diverticula of the intestine to be detached from it, we should have a true enterocœle, which would then give rise to the epithelial musculature of the wall of the body and of the intestine, the excretory organs would thus acquire their primitive relations to the diverticula, and would serve, at the same time, for the evacuation of the generative products. It is probably along some such lines as these that the Oligochæta and Annelids have been developed from a Leech-like form.

In connection with this subject Dr. C. Chun* points out that, though there are several points in common, there are also some important differences in the development of the Ctenophora and marine Planaria. In both there are four small and four large cleavage-spheres, and the gastrula is formed by epiboly. While, however, the rapidly multiplying small cells of the Ctenophora represent the rudiments of the ectoderm and mesoderm, in the Planaria there arise four primitive mesodermal cells, which alone form the mesoderm. He is not certain that the resemblances point

* Biol. Centralbl., ii. (1882) pp. 5–16.

to genetic relationships, and suggests that these observations may only be the commencement of the raising of a new set of problems.

Entozoa confounded with Trichinæ.*—P. Mégnin points out that *Trichina spiralis* is not the only worm which may become encysted in the peritoneum or the muscles; and after showing how various naturalists have been led to speak of Trichinæ where none exist, he gives an exact account of the character of *T. spiralis.* It is an extremely delicate, filiform worm, with a very narrow anterior extremity, in the centre of which is the small round mouth; the posterior end is truncated, and has the anus in its centre. The intestinal tube is straight, and has a distinct œsophagus, stomach, and rectum. The agamic encysted forms are chiefly found in the muscles of animal life, but they are sometimes to be seen in the adipose tissue and in the muscles of the intestinal walls. Around the spherical space occupied by each coil, there is a deposit of colourless granular matter, which is more abundant towards the two poles, and has generally an elongated conical form. A single cyst or capsule rarely contains more than one worm. Later on, the walls of the cysts become incrusted with calcareous salts, within which the *Trichina* may continue to lie. After its death fatty degeneration occurs.

The European mole is often in spring infested, on the external surface of its stomach and intestines, with small cysts, in which a worm is coiled up. The integument of this parasite is markedly striated, the mouth has a papilla, and the body is more cylindrical than that of *Trichina;* in addition to these and other characters there is a conical tail. This is the larval stage of *Spiroptera strumosa.* In some Spanish and other lizards there may often be found a number of cysts scattered throughout the body; here again the anatomical characters are those of *Spiroptera* rather than of *Trichina;* and, in fact, the organism is *S. abbreviata.* Other forms from other animals, including the frog, are described; one belongs to the genus *Dispharagus*, all the rest to *Spiroptera.* The author justly points out that a careful comparative study should be made on all occasions when it is stated, or believed by the observer, that he has to do with the genus *Trichina.* The paper will be very useful to all who are engaged in researches of this kind.

Life-History of the Liver Fluke.†—Professor R. Leuckart states that his search for the young of *Distomum hepaticum* has at last been rewarded; specimens of what he regarded as *Limnæus minutus* were obtained from Dresden, and many of these were, after a few days, found to have in their respiratory cavity, and generally, near the kidney, a number of the embryos with which he had in vain attempted to infect larger snails. More or less rounded bodies were found more or less closely packed together, and attached by a delicate cellular envelope to the operculum; there could be no doubt as to the relation of the parasite to the embryo, not only was there

* Bull. Soc. Zool. France, v. (1881) pp. 189–98 (2 pls.).
† Arch. f. Naturgesch., xlviii. (1882) pp. 80–119 (1 pl.).

the characteristic cephalic process, but the simple x-shaped eye-dot was converted into two irregular black dots, while the internal changes that were seen indicated a metamorphosis into the sporocyst stage.

When the embryo escapes from its shell it contains all its germ-cells, which occupy the hinder portion of the body-cavity, while the anterior half is filled with a granular mass, which may be looked upon as the rudimentary enteron. At this stage the embryo has, in its general structure, so striking a resemblance to the Orthonectida of Giard, that the author is of opinion that these forms, just like the Dicyemidæ, must be regarded as of the Trematode group; the fact that they never pass beyond an embryonic condition, even although they exhibit a complete differentiation of the sexes, need not cause much astonishment, if we reflect that the sexually mature entozoa of a large number of Invertebrates are, after all, to be morphologically referred to more or less developed larval forms; in addition to this, we may note that there is not really the difference which there is ordinarily supposed to be between the germ-cells of the Trematoda and the female generative products. After swimming actively about for some time, the embryo makes its way into a snail, and generally into the respiratory cavity. As a rule, the ciliated investment is now lost, and the two eyes become separated; the form of the body meanwhile ceases to be conical, and becomes more or less compressed. The loss of the cilia is, of course, the expression of the commencement of the parasitic life; before it begins the animal makes some powerful peristaltic movements, which loosen the cells. As soon as the animal has completely entered into a resting-period, a thin layer of clear cuticular substance is secreted around its outer surface; this forms a kind of cyst, which is perfectly adapted to the form and changes in form of the body. Increase in size chiefly affects the germinal cells, some of which rapidly, and others less rapidly, divide repeatedly, and give rise to larger cell-aggregates; this growth leads to the enteron being pushed forwards, till it forms a kind of inner cap for the cephalic end of the body, the eyes become altered in position, and the number of the refractive granules increases.

All the germinal cells, however, do not undergo division and further development, a large number remain in their earlier condition; so again, during the first days of parasitic life, a number of sporocysts die down; some of those that become further developed would seem to have the power of dividing; at any rate the increase in the size of these parasites is less an active than a passive phenomenon; it is the consequence merely of the regular growth of the germ-spheres, which reacts on the form of the embryo; the walls of the body now become thicker, and lose largely their power of contractility; the ciliated funnels would seem to disappear, and even the eyes become obscured; the last signs of the rudimentary enteron are now also lost. Some of the germ-spheres contained within the body begin to elongate, till they form tubes of some considerable size, presenting a specific internal and external organization and forming definite creatures. The inequality in the rate of development of the

germs which was noted is now more distinctly manifested by the presence of organisms at very various stages of development. To the author's great astonishment he found that the products of the sporocyst were not *Distomata*, but *Rédiæ;* these, when free, are about 0·4–0·7 mm. long, but are capable of considerable contraction and extension; a head, median region, and tail-end may be distinguished; the two former are separated sharply from one another by a prominent encircling ridge, while the body is distinguished from the tail by two blunt projecting processes, developed from the ventral surface. The tail is bluntly conical. The lips surrounding the mouth serve as attaching organs. The organization of the *Rédia* presents very considerable resemblance to that of the embryos, the organs being only more strongly individualized and the elementary parts more distinct, in correspondence with the larger body and higher function. The encircling ridge may be looked upon as a kind of skeletal girdle, which serves as the point of attachment for the retractors of the head and pharynx. As to the mode of development of this *Rédia*, the author believes that it passes through a gastrula stage; though some points were made out, the history of the germ-spheres could not be followed. Here then, unfortunately, this part of the history comes to an end; luckily some other snails were obtained in which were found three *Rédiæ*; two of these contained Cercariæ, but a third had a tail-less *Distomum* which is believed to have been a young *D. hepaticum.*

In conclusion, some remarks are made on the small Lymnæids which are believed to be the hosts.

Excretory Apparatus of Turbellaria.* — In continuing his studies,† P. Francotte points out that Hallez denies the existence of the excretory canals in the genus *Monocœlis*, while Schultze and others distinctly affirm their existence. The author has been able to confirm the latter doctrine, so far as it applies to the presence of these canals, but he has not been able to detect any communications with the outer world. On the other hand, he has discovered the presence of ciliated terminal infundibula, very similar to those of the Trematoda and Cestoda.

In dealing with the genus *Monocœlis*, it is, first of all, necessary to take for examination perfectly fresh specimens; there will then be seen a system of principal canals, fine secondary canaliculi which form a plexus throughout the whole, and vibratile infundibula united to the plexus by a canal. There are two pairs of principal canals on either side of the middle line, two external and two internal; these are united with one another by several anastomoses of the same size; the distinct walls are transparent and very hyaline, but no definite histological structure could be made out. At certain points there may be seen a long conical filiform cilium; the canals contain a transparent liquid in which are some small granulations. The secondary canaliculi arise from the ciliated infundibula and have a very delicate wall, of no distinct structure; they are best made out in the anterior

* Bull. Acad. R. Belg., iii. (1882) pp. 88–98.

† See this Journal, i. (1881) p. 460.

region; the infundibula are conical, and have, in optical section, a triangular form; the wall is here again transparent and hyaline. It is interesting and important to note that in sections of these worms, though prepared by different methods, no trace of the existing canals has yet been detected.

The Dendrocœla (as represented by *Polycœlis nigra*) would appear to be without the secondary canaliculi, the infundibula being connected with the principal by five canals. The principal canals here form a plexus and would seem to open to the exterior; the highly refractive wall here again appears to be without any definite structure. Throughout their whole extent there is a continuous vibratile line lining the canals. The infundibula are conical and their wall is formed by the walls of the canals into which they open, but the black pigment of the form examined prevented the author from seeing whether or not the canals are completely closed.

New Parasites.*—J. Fraipont describes some parasites of *Uromastix acanthinurus*. Only five *Tœniœ* are yet known from any of the Saurians; the new form, *T. alata*, has two aliform delicate expansions on the neck; the transparency of the joints allows of the easy detection of the two pairs of longitudinal canals belonging to the excretory system, which extend throughout the whole of the body. In the terminal segments there were detected a considerable number of eggs, with a thin but resistent membrane, and each containing a hexacanth embryo, surrounded by an embryonic envelope.

The presence of an *Echinorhynchus* is interesting as, apparently, no species of the genus has ever yet been found in a Saurian; the present species is called *E. uromasticis*. *Filaria candazei* is a new species found in the subcutaneous connective tissue and between the different muscles of the body; the female is much larger and longer than the male (100–120 mm.). The muscles are arranged on the polymyarian type. Special organs in the shape of four pairs of pediculated appendages bearing each two small papilliform growths on their free end, are arranged symmetrically on either side of the sheath of the penis.

Tube of Stephanoceros Eichornii.†—Mr. T. B. Rosseter, on severing the longitudinal muscles that extend down the peduncle (cutting the tail through close to the base), saw the *Stephanoceros* swim out of the tube at the oral orifice, leaving it intact, and thus confirming the view of Mr. Slack, as against that of Mr. Pritchard, that it is tubular and not a solid gelatinous mass. He considers it clear that "it is perfectly hollow: there is no attachment between the cell and the creature, and it is quite as independent of its cell as *Melicerta ringens* is of its cell." The dragging down of the upper portion of the tube is caused by the teeth of the tentacles overlapping the sides and not from attachment to the neck of the creature.

Mr. J. Badcock, however, considers that both parties are right in

* Bull. R. Acad. Belg., li. (1882) pp. 99–106.
† Sci.-Gossip, 1881, pp. 107–9 (6 figs.).

the view they have taken; for, as the result of his own observations, he finds that when young the tube is hollow, but when old the cavity becomes filled up with a mucous substance.

Echinodermata.

Structure of Pedicellariæ.*—A. Foettinger has examined the gemmiform pedicellariæ of *Sphœrechinus granularis.* He finds that the three more or less ovoid glandular sacs which are formed on the stalks of these, are surrounded by the common epithelial membrane which invests the whole of the organ. They open to the exterior by an orifice at their superior extremity, and they alternate in position with the valves which form the head of the pedicellaria.

After decalcification by means of chromic acid, and staining with carmine, the following tissues can be seen on making a transverse section of a pedicellaria at the level of these glands; there is an external epithelium, containing a large number of pigment-corpuscles, a layer of connective fibrillæ which separates and unites the glandular sacs; these have an external layer of flattened muscular fibres, with an oval nucleus, and these fibres are arranged concentrically around the orifice of the gland; the contents of the sac vary greatly, being in some cases formed of a granular, and probably mucous, matter which contains refractive corpuscles which swell up under the action of water, and are, doubtless, modified nuclei; in other cases the substance is filamentous, but this is ascribed to the coagulating action of alcohol; this substance swells up considerably on contact with water, &c.; and this increase in volume, when it happens with an uninjured pedicellaria, must lead to the outpouring of the contained mucus. When certain transverse sections are made, the contents of the sac are seen to be constituted almost solely of protoplasm with nuclei and cell-walls more or less intact. In longitudinal sections some of the glands present a protoplasmic layer investing the base and the walls. The author would explain these facts by considering that the glandular sacs are primitively filled by a tissue formed of polyhedral cells, and making a compact mass. At a certain time these cells are converted into mucus, and this change goes on until all the external cells are affected by it.

The three valves which form the head of the gemmiform pedicellaria are pyriform in profile view, and ovoid from in front; the enveloping layer is merely epithelium; below it there is a layer of granular and fibrillar connective tissue, which is generally very delicate, but is abundant between the valves, and near their upper surface. Beneath this tissue we find a glandular sac, which is double above; at the peripheral extremity the two branches unite into a single canal. This glandular sac would also seem to have its primitive contents formed of a compact cellular tissue. *Echinus melo* and *Echinometra subangularis* have at the base of the head of their pedicellariæ organs which are very probably homologous with those found on the stalk of *S. granularis.* M. Foettinger has also examined the pedicellariæ of

* Arch. de Biol., ii. (1881) pp. 455–96 (3 pls.). Bull. Acad. R. Belg., ii. (1881) pp. 493–504.

Diadema setosum and *D. mexicanum;* these, which are about 2 mm. long, are club-shaped and end in a very short and delicate pedicle; they enclose three large elongated glands with an orifice at their upper end; the glands are closely applied to one another, but have superiorly, where they diminish in size, six separating cavities which may be looked on as the homologue of the head of the pedicellariæ of *S. granularis.* In *Mespilia globulus* the pedicellariæ are excessively small and very numerous. In *Strongylocentrotus lividus* and *S. drobachiensis* the gemmiform pedicellariæ have a stalk which has considerable resemblance to that of the ophiocephalous and tridactyle pedicellariæ. When we compare *S. granularis* with *Echinometra* and *Diadema* we find that in the first the glands and head are equally developed, that in the second the glands are rudimentary, and that in the third it is the head which is rudimentary.

The author, not having been able to make any original observations on living forms, accepts the views of Sladen, who was the first to direct pointed attention to this subject.

Circulating Apparatus of Starfishes.*—E. Perrier and J. Poirier, after noticing the accounts of earlier observers, in which there is a large amount of very perplexing contradiction, state that they find that the vascular apparatus described by Ludwig in the partition of the infrabrachial canals has no existence, that the partition is not continuous, but that it is reduced at certain points to a vertical lamella while at others it presents distinct foramina. The body adherent to the hydrophoral canal, where Ludwig sees a plexus of vessels and which he regards as being the heart, is (as Jourdain showed in 1867) nothing but a gland; the same has been shown to be the case in the common sea-urchin, and Koehler has found the same to be true for the Spatangidæ. As the Ophiuroidea present a similar structure, we may say that, in all Echinoderms, this so-called heart is a simple gland.

The system of lateral branches described by Hoffmann as arising from the infrabrachial canals, has been detected, but a different account is given of its relations. These lateral branches do not curve round the ambulacral pore, but pass straight to the edge of the ambulacral groove; what Hoffmann took for the second branch of the horse-shoe is a fresh canal, independent of and identical with the first; and these two canals pass, parallel to one another, to the edge of the arm; there they bifurcate and the two neighbouring branches together pass through a foramen between two contiguous ambulacral, and the adjacent adambulacral pieces. In these foramina the two branches unite to form a common branch, which opens directly into the general cavity. There is always a similar hole between two contiguous ambulacral pieces, so that the infrabrachial canals always communicate with the general cavity by as many holes as there are ambulacral pieces. The infrabrachial canals and the branches which they give off are, therefore, merely dependences of the general cavity, divided into two communicating parts by the

* Comptes Rendus, xciv. (1882) pp. 658–61.

tentacular canals, and the system of ambulacral pieces. These canals also present a mode of partition which is remarkably like what is found in the brachial cavity of the Comatulæ; this mode is alone found somewhat late in the Crinoids, and we see that there is, therefore, in them "an accidental character" which contrasts strongly with the almost absolute fixity of the relations of the ambulacral apparatus. "This last is the essential and dominant character in the organization of an Echinoderm." The authors also find that the integument of the infrabrachial canals is formed of small bipolar cells, the swollen portions of which are near the external surface.

Genital Passages of Asterias.*—S. Jourdain describes the presence of five vasculiform ducts, lying below and applied to the internal face of the dorsal integument, the sides of which form a pentagon. The angles of the pentagon point to the interradial septa, and a vessel, embracing each septum, establishes a continuity between the branches which correspond to the sides of the pentagon. This vasculiform pentagon was regarded by Tiedemann as a dorsal venous circle, but from each septum there are given off two branches which become connected with the appended genital glands, and they are the only ones which are given off from it. The author is of opinion that this pentagon has no relation to the proper vascular system. The vessels do not have the relations of blood-vessels, but they are in communication with the interior of the gland and its diverticula; in other words, they are disposed as the excretory canals. The vasculiform dorsal plexus varies in size with the activity of the genital glands, and its walls are provided with muscles, while the internal ciliated surface has a projecting fold of glandular tissue. At the point of attachment of the enlarged interradial septum, which corresponds to the madreporic plate, the ducts of the pentagon open into an elongated fusiform sac, which is invested in an elastic membrane containing muscular fibres. At the extremity of this sac there are two brownish pyriform bodies, which are in connection with the canals of the pentagon; these, with the sac and its projection, are what most writers have considered to be the heart. They are not so, but merely dilated continuations of the pentagon. The fusiform sac opens into a circum-oral ring, to which are attached small paired globular bodies, almost similar in histological structure to the pyriform bodies. An orifice, of extremely small size, and very difficult to detect, is to be found where the sac is continuous with the circum-oral ring; so that, *Asterias*, just as in Holothurians, the sperm and the ova are passed to the exterior by a pore in the circum-oral circlet, and not by interradial perforated plates.

E. Perrier and J. Poirier state,† however, that specimens of *Asterias glacialis*, alive and depositing ova, are seen to have their ova escaping by ten groups of small holes, set a little above each interradial angle; each group contains three to six orifices; in specimens that had been opened from the dorsal surface no ova were to be found

* Comptes Rendus, xciv. (1882) pp. 744–6.
† Ibid., pp. 891–2.

in the circular dorsal canal, or in the tubular pouch surrounding the hydrophoral canal; this pouch serves as a means of communication between the dorsal and ventral circular canals, and is really nothing more than one of the spaces formed by the peritoneal membrane, and enlarged; but neither it nor the dorsal canal have anything to do with the excretory apparatus of the generative system.

Cœlenterata.

Clavularia prolifera.*—After a description of this new Alcyonarian, G. v. Koch discusses the mode of connection of the buds with the trunk; he points out that it is a remarkable fact that these buds are not mere outpushings of the body-wall of the mother-polyps, but that at the base of each bud there is a canalicular network in the thickened connective substance of the mother, by which the two polyp-cavities indirectly communicate with one another. Discussing the question of its origin, the author shows that, if it is secondary, or if, in other words, the young polyp first developes as a simple evagination, and gives rise to the plexus by a partial fusion of the intermediate substance, it would be a structure which owed its existence to adaptation, or had only a physiological significance, such as might be explained as due to the more or less complete isolation of the polyps. On the other hand, if it is primary, or, if it gave rise to the young bud, then we should have to seek its morphological significance, and might compare this canalicular network with the nutrient canals of the Gorgonida.

This important question could not be decided on the preserved specimen which the author has examined, but a study of some allied forms shows that in this group of corals the digestive cavities of the buds never open directly into that of the mother, and that there are a series of intermediate stages from those in which the polyp-buds are derived from simple stolons, and those in which the stolons form canals in the thickened mesoderm, and those, lastly, in which the thin partition between the bud and the mother is perforated by small orifices. We may therefore conclude that the more or less incomplete separation seen in the Alcyonaria has a certain use, and that it is not an adaptive arrangement, but one which may be referred to the formation of the stolons; the canalicular network in the mesoderm of the mother-polyps, which lies at the base of the buds and connects them with the mother, is a stolon-formation (in its widest sense). And, further, we find that in the Alcyonaria asexual reproduction is never effected by division or direct gemmation, but always indirectly, or by stolons or structures homologous therewith.

A study of the new species throws some light on the horny sheaths of the spicules, and their relations to the ectoderm, for we find that the younger spicules are always invested in a protoplasmic nucleated sheath, which may also be frequently made out in older examples, where we find cells connected by pairs and having within

* Morph. Jahrbuch, vii. (1881) pp. 467–87 (2 pls.).

them the young spicule. The doctrine, then, of Kowalevsky, that the spicules arise from cellular elements, may probably be extended to all the Alcyonarians. And the same would seem to hold for the horny sheaths. These cells found in the mesoderm would seem to have been derived from the ectoderm, whence cells have been observed to wander into the middle layer; as this has never been noted with regard to the endodermal cells, we may conclude that the hard skeletal parts of the Alcyonaria, whether spicula or horny sheaths, are derived from the ectoderm.

Porifera.

Sponges of the Gulf of Triest.*—In his second paper on the marine fauna of the Gulf of Triest, Dr. E. Graeffe deals with the Spongiariæ; with which O. Schmidt has already dealt. It is pointed out that sponges have but few enemies; some of the species of *Doris*, *Doriopsis*, and *Fissurella* attack their outer layers; on the other hand, they have a number of parasites, Algæ and Chætopod Annelids being the most conspicuous. *Gammarida* are also not unfrequently found. Some silicious sponges have their outer surface affected by small Aphroditeidæ and by Hydroid Polyps.

In the list given by the author especial attention is directed to the places in which they are found, and their time of reproduction, with some notes on the localities of the ova and larvæ.

Spongiophaga in Fresh-water Sponges.†—Mr. E. Potts insists that Mr. Carter is mistaken in considering that the slender curling or twisted tendrils ‡ of the statosphere of fresh-water sponges of the genus *Carterella* § are parasites, as described by him under the name of *Spongiophaga Pottsi*.‖ Prof. Leidy, by whom they were examined, says that "there can be no question as to the tendrils being part of the structure of the statoblast—homogeneous extensions of its inner capsule."

The function of the tendrils is apparently to meet the emergency occasioned by the looseness of the skeleton structure, from which the sarcode-flesh dying early washes away, most of the spicules soon following in the winter floods. The eggs are thus left to the protection of the tendrils, which lap them together, bind them to the remaining spicules or the roots of water-weeds or shore plants, or assuming the rôle of the hair which the plasterer uses, bind the deposited silt about them, and both to the stones, where they await the appointed time for a new growth. The resemblance in material structure of these tendrils to that of the specialized hooks of some of the Polyzoa is very striking.

Mr. Carter, as the result of subsequent examinations,¶ agrees with Mr. Potts' view as to the filaments being in reality cirrous appendages on the statoblasts and not Spongiophaga.

* Claus' Arbeit., iv. (1882) pp. 313–21.
† Proc. Acad. Nat. Sci. Philad., 1881, pp. 460–3.
‡ See this Journal, i. (1881) p. 613.
§ Ibid., p. 901. ‖ Ibid., p. 901.
¶ Ann. and Mag. Nat. Hist., ix. (1882) pp. 390–6.

New Fresh-water Sponges.* — Mr. E. Potts describes three more curious fresh-water sponges. One (*Meyenia crateriforma*) is of a very delicate structure; its framework of skeleton spicules is exceedingly meagre, and slightly bound together, scarcely amounting to a mesh system, and the numerous small white statospheres are found in recesses far larger than themselves. Another (*Heteromeyenia ryderii*) forms beautiful green masses, often four to five inches in diameter, and about a quarter of an inch in thickness. The surface is irregular, occasionally rising into rounded lobes; the efferent canals are deeply channelled in the upper surface of the sponge, five or six sometimes converging to a common orifice. The statospheres are numerous and rather small. There are two series of birotulate spicules. The third species belongs to the genus *Tubella*. This genus, established by Carter, contained only four species, all from the Amazon river. The new species is small, encrusting, and has been named *T. pennsylvanica*. The skeleton spicules are arranged in a simple series of single non-fasciculated spicules, in the interspaces of which the statospheres are abundant. These spicules are very variable in size and shape, but all are entirely and coarsely spined. The dermal spicules seem absent.

Protozoa.

Organization of the Cilio-flagellata.†—R. S. Bergh gives an account of the Cilio-flagellata observed in the Little Belt and in the fresh waters of Denmark; the first part containing "History" and "Bibliography," the second a description of ten genera and twenty species, and the third Phylogeny. The chemical composition of the various parts of the body is fully dealt with so far as that is possible by the use of reagents, as well as the anatomical structure. Seventy-three figures show what great variation is presented by certain forms, and how difficult it often is to define the limits of the species.

The *body* of all Cilio-flagellata is bilaterally asymmetrical, differing remarkably, however, in the various representatives; sometimes it is compressed from front to back (*Diplopsalis lenticula*, *Glenodinium Warmingii*), sometimes from above downwards (*Ceratium*, *Peridinium*), and sometimes laterally (*Dinophysis*, *Amphidinium*, *Prorocentrum*). It may be drawn out into horns (*Ceratium*, *Peridinium divergens*) or may be destitute of any.

They possess either a lorica (cell-membrane) (*Ceratium*, *Protoceratium*, *Peridinium*, *Protoperidinium*, *Dinophysis*, *Diplopsalis*, *Glenodinium*, *Prorocentrum*), or are naked (*Gymnodinium*, *Polykrikos*). The *membrane* consists either of cellulose or a similar hydro-carbon, and is coloured by chlor-iodide of zinc, pale violet (*Ceratium*, *Perid. tabulatum*) or intense red (*Perid. divergens*, *Protoperidinium*, *Diplopsalis*), or even pale red (*Prorocentrum*, *Glenodinium cinctum*). Those forms which have been closely examined do not contain silica. The more minute structure of the cell-membrane varies much; it is either transparent and structureless (*Glenodinium*) or ornamented with

* Proc. Acad. Nat. Sci. Phila., 1882, p. 12.

† Morph. Jahrbuch, vii. (1881) pp. 177–288 (5 pls. and 1 fig.).

reticulately arranged ridges (*Ceratium cornutum*, and *C. hirundinella*, *Dinophysis*), or the ridges do not form a network, but run more irregularly, pores also appearing (*Ceratium tripos*, *C. furca*, *C. fusus*); finally we find a division by bands into a number of plates of various sizes with smaller intermediate striæ, so that the plates show the reticulated structure, the bands on the contrary being transversely marked (*Peridinium*, *Protoperidinium*, *Diplopsalis*); in *Prorocentrum* (apparently) the membrane consists of two cuirasses, which are perforated with fine pores.

The *protoplasm* is apparently always separated into ectoplasm and endoplasm, which both show very varying differentiation. In the cuirassed forms the ectoplasm is always quite structureless and homogeneous; in *Gymnodinium* and *Polykrikos*, the most highly developed forms, it shows many peculiarities; in *G. gracile* it is very much wrinkled and folded, and in *G. spirale* it contains muscular fibrillæ in its inner layers; in *Polykrikos* trichocysts are developed in it. The endoplasm sometimes contains, at the same time, chlorophyll, and diatomin and starch, or some similar amylaceous matter (*Ceratium*, *Protoceratium*, *Perid. tabulatum*, *Protoperid. Michaelis*, *Glenodinium*, *Dinophysis acuta*, *Prorocentrum*), which indicates a mode of nutrition similar to that of plants; sometimes these substances are wanting, and the body contains digested organisms (*Gymnodinium*, *Polykrikos*), which indicates that alimentation takes place as in animals; finally, there seem to be some forms which are nourished neither by the agency of chlorophyll (the assimilation of carbonic acid) nor by animal matter, as we find in their endoplasm neither the above-mentioned colouring matter nor foreign organisms (as in *Protoperid. pellucidum*, *Perid. divergens*, *Diplopsalis lenticula*, *Dinophysis lævis*). The endoplasm in *Perid. divergens*, *Diplopsalis lenticula*, &c., is coloured slightly red; in the former it usually contains little drops of red-coloured oil. No contractile vesicle can be pointed out with certainty. In all the forms in which the nutrition could not be seen to be either assimilative or purely animal, a vesicle is found which often communicates with the outer world through the flagellum-furrow and a narrow canal, but is sometimes separated from it; probably its function is to take in sea-water (with nourishment).

The *nucleus* is generally single; only in *Polykrikos* we find four (larger) nuclei. Those of the Dinifera consist of a fine granular substance containing no nucleoli and colouring bright pink when treated with picrocarmine (after alcohol). Only in *Polykrikos* is there found a second sort of smaller nucleus (perhaps "primary nucleus" in the same sense as in the Ciliata). The nucleus of *Prorocentrum* still needs a closer examination.

The *locomotor apparatus*, the special characteristic of the Cilioflagellata, consists of long, powerful flagella and smaller cilia. These *cilia* spring either directly from the anterior end of the body (*Prorocentrum*), or are arranged in one or two contractile rows in a transverse furrow formed by two projecting plates or ridges (Dinifera). The furrow lies either at the anterior extremity of the body (*Dinophysis*, *Amphidinium*), or about the middle (the other forms); in *Gymnodinium*

spirale it is spirally twisted. The ciliary movement seems to go in one constant direction, beginning on the left of the ventral surface. In *Gymnodinium* there appears to be only one contractile row in the furrow. In *Polykrikos* there are eight furrows independent of each other. The edges of these furrows are interrupted on the ventral side; the posterior ones continue in a peculiar system of horns and ridges, which are either placed close on each other, as on the small ventral side of *Dinophysis*, or are separated from each other as a right and left hand division (*Protoperidinium*); this entire apparatus serves for limiting the longitudinal furrow. In the other forms either the horns alone persist (*Peridinium*), or the ridges (*Diplopsalis*, *Glenodinium*), or both are absent (*Ceratium*, *Gymnodinium*.) The *Flagellum* is inserted either through a wide ventral aperture in the membrane (*Ceratium*) or through a narrow fissure in the longitudinal furrow, either at the anterior pole (*Prorocentrum*) or the posterior pole (*Amphidinium*, according to Claparède and Lachmann) or in their neighbourhood.

Of the *propagation and development* of the Cilio-flagellata little is known with certainty. We find fission as well as conjugation. Transverse fission results either in a free-swimming animalcule (as for example in *Polykrikos*, in Allman's *Perid. uberrimum*), or in withdrawal into the old membrane (*Perid. tabulatum*), or finally in certain cysts, which are either round (*Glenodinium cinctum*, *Gymnodinium* according to Stein) or have peculiar, strange (horned) forms (*Perid. tabulatum* according to Stein). Conjugation is especially shown by Stein in *Gymnodinium pulvisculus*; but several of his statements, the author thinks, require a complete revision.

Under the head of "Phylogeny" the author endeavours to unravel the relationship of the organisms, even for each genus and species. The results of such an attempt could not be very definite, for, as he himself says, we have not the necessary palæontological evidences and consequently the intermediate forms are wanting that have existed in past times. The author's six genealogical trees can therefore only be taken for what they are worth, that is as a representation of the more or less intimate relation which we can recognize between certain forms. It is, however, a clever and convenient method of expressing one's views of the affinities.*

According to the author, the Flagellata form a point of departure from which are developed phylogenetically (diverging on different sides), the *Noctilucæ*, Rhizopoda and Cilio-flagellata. The oldest forms of Cilio-flagellata were the Adinida, of which only one living species (*Prorocentrum*) is now known. They acquired small cilia, and a bilaterally asymmetrical form. There later appeared the ciliary apparatus, at first posteriorly and then anteriorly limited by the ridges of the membrane, so that a transverse furrow was formed (Dinifera) which was originally on the anterior margin (*Dinophysis*, *Amphidinium*); then the flagellum was removed from its primary position posteriorly, whereby a longitudinal furrow was formed, at first confined by a complicated apparatus of ridges and horns. Still

* Cf. Arch. Sci. Phys. et Nat., vi. (1881) pp. 402-4.

later the body became rounded, the transverse furrow moved in a posterior direction, and the membrane acquired plates, whilst the longitudinal furrow-apparatus remained entire (*Protoperidinium*). From this point began the development in two directions, since on one side the ridges (*Peridinium*, *Protoceratium*, *Ceratium*) and on the other the horn-like processes of the longitudinal furrow (*Diplopsaria*, *Glenodinium*) were reduced, and finally the plates coalesced. The highest division is represented by the Gymnodinida in which subfamily the membrane is quite abolished, and numerous differentiations of the protoplasm developed. Finally, springing from these, are forms in which the flagellum is reduced, but in which a cytostom and cytopyge are differentiated in order to give origin to the Peritricha, the oldest ciliated Infusoria (*Mesodinium*).

L. Maggi * establishes the occurrence of *Ceratium furca* Ehrenberg, hitherto almost exclusively known as marine, in certain lakes of Upper Italy (Lago di Candia, near Ivrea, and Lago di Annone, in Brianza); at the same time he devotes much attention to the synonymy of this species and to the history of the investigations into the phosphorescent powers of the *Ceratia*. Like Claparède and Lachmann, he regards *Peridinium lineatum* as identical with *Ceratium furca*. The form was not observed alive, but only the remains of its tests; among these occurred in the Lago di Candia, a considerable number somewhat differently shaped, which the author thinks right to constitute a special variety, under the name *lacustris*.

The same writer † gives a list of all the Cilio-flagellata known to him through literature or by original observation, adding the synonyms and habitats of each form. He retains the following five genera:—*Ceratium* (with seventeen species, two of which are fossil), *Peridinium* (with thirty species, all recent, two fossil ones also occur), *Dinophysis* (seven species), *Amphidinium* (one species) and *Prorocentrum* (one species). He believes that Claparède and Lachmann have gone too far in their reduction of the number of the species, and have allowed themselves to be guided by reasons which will not bear investigation. He endeavours to show here, as in another place, that the Cilio-flagellata were originally derived from the sea, in which even at the present time they attain so great an importance, and have only later extended into fresh water. By this means the circumstance is explained of their inhabiting more particularly the larger fresh-water lakes, for in these are found conditions resembling to a certain extent those of the sea. On this view Prof. O. Bütschli‡ remarks that the author has not paid attention to Stein's writings on the Cilio-flagellata, or he would have seen that Stein distinguishes three additional genera, *Gymnodinium*, *Hemidinium*, and *Glenodinium*, but is inclined to remove the genus *Prorocentrum* from the group.

L. Maggi § further arranges together all the Cilio-flagellata known

* Bollet. Scientif., i. (1880) pp. 125–8. Cf. Zool. Jahresber. Neapel for 1880, i. p. 167.

† Op. cit., ii. (1880) pp. 7–16. Cf. tom. cit., p. 167.

‡ Tom. cit., p. 167.

§ Rendic. R. Istit. Lombard. xiii. (1880) p. 20. Cf. Zool. Jahresber. Neapel, tom. cit., pp. 167–8.

to him through the literature of the subject, according to their mode of occurrence. Thus the forms hitherto found in the different seas are enumerated, after which a catalogue is given of those belonging to fresh water, according to the manner of their occurrence in lakes, marshes, streams, ditches, &c.; and finally a list of those forms which have been hitherto found in both sea and fresh water. These last include four forms, viz. *Ceratium tripos* Ehrb., *furca* Ehrb., *Peridinium spiniferum* Clap. and Lachm. (according to Maggi's observations), and *Prorocentrum micans* Ehrb. The paper concludes with an enumeration of the known fresh-water forms, arranged according to the different countries in which they occur, and going so far as to give for each form the particular locality in which observers had met with it. From this section may be specially selected the fact that the author records *Peridinium pulvisculus*, Ehrb., *spiniferum* Clap. and Lachm., *tabulatum* Schm., as well as *Ceratium longicorne* Perty, as found by him in Upper Italy. It is unnecessary to go more fully into Maggi's results, as he has made no attempt to examine closely and compare the forms described by various writers, in order to decide their claims, but contents himself with simply enumerating them.

Infusorian with Spicular Skeleton.*—R. S. Bergh has obtained large quantities of the Infusorian described by Claparède and Lachmann under the name *Coleps fusus*, in the open sea off the Small Belt (Denmark). The peculiarities which he has observed in this species appear to him sufficient to raise it to the rank of a new genus, whose principal character, distinguishing it from *Coleps*, is that the skeletal sheath is not a continuous fenestrated test, but consists of single disconnected spicules. These are parallel to the long axis of the animal, which has a considerable longitudinal extension and is pointed at the aboral pole; they are arranged in five transverse series, showing considerable differences between their heights. The spicules are provided with short lateral cross-branches, differing (but not constantly so) in number in the different series; they constitute an indication of reticulate structure, but, as already stated, they are not so much developed as to unite the spicules together. The spicule-elements of the skeleton consist of an organic substance, and lie imbedded in the peripheral protoplasmic layer. The cilia are placed above, not between them. A compact crown of cilia is found at the oral pole. The simple, roundish nucleus lies within the middle series of spicules.

Contractile Vacuole of Vorticella.†—After an historical introduction relating to the controversy about the presence of a membrane to the contractile chamber, J. Limbach describes his own observations on the subject as follows:—In pathologically altered specimens of *Vorticellæ*, in which their characteristic ciliated organ is swollen up and the body is detached from the pedicel, the contractile vacuole

* Vidensk. Meddel. Naturh. Foren. Copenhagen, 1879–80, pp. 265–70, woodcuts. Cf. Zool. Jahresber. Neapel for 1880, i. p. 170.

† Kosmos, (Zeitschr. poln. Naturf. Ges. Kopernicus), 1880, pp. 213–21. Cf. Zool. Jahresber. Neapel for 1880, i. p. 169.

becomes more and more distended, so as to include as much as three-fourths of the breadth of the body. It is scarcely probable that an unusually thin membrane in connection with the vacuole, if present, should be able to stretch to such an extent, without bursting, a consideration which appears to furnish additional evidence in favour of the absence of a membranous wall in the vacuole. Limbach, by observation of *Vorticella cyathina* during fission, has been able to determine the opening of the vacuole into the vestibule, and the expulsion of its liquid through the opening of the latter. The same results were obtained from the abnormal *Vorticellæ* above mentioned. Thus the contractile vacuole constitutes an excretory organ, although it may at the same time assist in the function of respiration.

Geographical Distribution of Rhizopoda.*—C. Parona gives a review of the Rhizopoda found by Leidy in North America, of those met with at the same time in Europe, and finally of those found since then in Italy. The astonishing agreement in the Protozoan faunas of districts so widely separated prompts him to raise the question whether the laws of phylogenetic development are hereby modified, a question which he answers negatively. This agreement is explained, according to his view, by the original derivation of the Protozoan faunas of both regions from a common source, and this must undoubtedly have been a marine source.† The closely similar alterations which have taken place in the circumstances and manner of life which the primitive Protista-faunas of the two continents have undergone in the course of ages, are considered by the author to have gone so far as to cause even the development of closely similar forms. He is therefore inclined, at any rate in this case, to admit a polyphyletic origin of species.

Classification of the Gregarinida.‡—B. Gabriel puts forward in two places a new classification of this group, based on his investigations into the process of reproduction in the Gregarines. He has been led to take this course by finding the principles advanced up to the present time by Stein and Schneider, and depending essentially upon the morphological peculiarities of the mature forms, to be insufficient; he therefore believes that a classification can only be based on the reproductive relations of these organisms. The presence or absence of a septum (the point of distinction between Mono- and Polycystidæ of Stein and Schneider) has in his eyes no deep importance, inasmuch as he has found at Naples, in *Typton spongicola*, a Gregarine, which in its early life is a septum-less Monocystidean, but acquires later not only one, but numerous transverse septa, and thus presents a colonial or strobila-form which arises by terminal budding, and whose segments are individually capable of independent reproduction. Gabriel finds the attaching apparatus of

* Bollet. Scientif., ii. (1880) pp. 43–50. Cf. Zool. Jahresber. Neapel for 1880, i. p. 127.

† Prof. O. Bütschli (loc. cit.) remarks on this that this opinion might be extended with probable accuracy to all fresh-water faunas.

‡ Ber. Versamml. deutsch. Naturforscher u. Aerzte, 1880, pp. 82–3. Cf. Zool. Jahresber. Neapel for 1880, i. pp. 160–1.

the Polycystideæ to have no greater importance, it being found similarly developed in Monocystideæ as well. The method of generation and development exhibits important variations both in the Mono- and Polycystideæ, and, indeed, is repeatedly found to be identical in members of both the groups. The author at first considered that the Gregarines should be broken up into two subdivisions, according as encystation occurs in the course of reproduction or does not; these were termed respectively *Acystoplasta* and *Cystoplasta*. He even found that in a Gregarine obtained from *Julus sabulosus* (and probably identical with *Stenocephalus Juli* Schn.), the spore-formation was completed without encystation, and without alteration of any kind in the shape of the body. He considers, however, this case not of sufficient importance to establish the above two subdivisions, and therefore distinguishes three divisions by the process of development and spore-formation; their characters may, however, be stated at the outset as difficult to understand, owing to the very indistinct preliminary notices in which the results of the author's developmental researches are presented. We give the characteristics of these three divisions as follows in the words of their author:—

"i. *Greg. Isoplastæ.*—The germs of the Gregarinæ and the series of the Myxomycetes appear at the same time, and both take their origin from the differentiated body-mass, but each for itself and independently one of the other. *Cystoplasta* represents Myxomycete forms by plasmodia.

"ii. *Greg. Proteroplastæ.*—The body-mass of the Gregarinæ, when generatively mature, becomes differentiated into a Myxomycete plasmodium. The Gregarine germs take their origin from this. *Acystoplasta.*

"iii. *Greg. Hysteroplastæ.*—The Gregarine germs first originate from the differentiated body-mass; the series of the Myxomycetes proceeds exclusively from certain transformations of the germs of the Gregarines (amœboid bodies). *Cystoplasta.* Myxomycete forms represented by plasmodia with radiating processes, pigments, calcareous corpuscles, and Mycetozoa."

The Myxomycete forms which produce psorospermiæ are regarded by the author as derived from disintegrated Proteroplasta, but the "sickle-shaped bodies found in Vertebrata and claimed as Gregarines by Eimer," on the other hand, as allied to the Hysteroplasta.

Psorospermiæ in Man.*—B. Grassi has found in the excrements of a boy and of a young man during a long period ($2\frac{1}{2}$ months in the first case) numerous bodies which after much hesitation he describes as oval Psorospermiæ (Coccidia). They exhibit a number of variations in size and form; they are sometimes globular, sometimes elliptical; in the first case they generally measure ·008 mm. in diameter, but in the latter usually ·008 to ·006 mm.; they have a distinct, and in the larger individuals a double-contoured test, and finely granular contents, completely filling the shell and containing

* Rendic. R. Istit. Lombard., iii. (1880) 3 pp. Cf. Zool. Jahresber. Neapel for 1880, i. p. 162.

from one to eight roundish nucleoid bodies. The contents may also be sometimes quite homogeneous or somewhat condensed and retracted from the test, and in many the protoplasm contained from one to six semilunar homogeneous glistening bodies, which, however, judging by the very poor figure given of them, show no special resemblance to the sickle-shaped bodies of Coccidia. The behaviour of these bodies towards various reagents and staining substances is also described. From all this the Coccidian character of these structures seems to be still doubtful. The two patients exhibited no complaints to which the presence in them of these parasites might be referred.

Myxosporidia.*—Under this term, which is introduced † by Professor O. Bütschli, may be mentioned the so-called parasitic plasmatic tubes of the pike's bladder, discovered by Lieberkühn, and belonging to the so-called Fish-Psorospermiæ, so widely distributed in these animals. According to Gabriel, they have no intimate connections with the Gregarinæ, as Leydig, and later Lieberkühn, have endeavoured to show; the following are the chief reasons which he advances for this opinion. These very variously shaped protoplasmic structures at no period of their life possess an envelope like that of Gregarinæ, and they are entirely non-nucleate. Moreover, the surface of the body frequently developes extensions and radiating processes of a very peculiar character, appearing now pointed, now finely fringed, sometimes hair-like and often branched as well, and consisting of protoplasm which is quite transparent, though not entirely without granules. These stellate processes cannot be directly compared to pseudopodia, for though they are protruded they are not retracted again. They consist "of what may be called a thread-drawing substance, which can issue forth with ease but cannot be again retracted." A substance of this nature is said to be peculiar to the protoplasm of Myxomycetes and to certain plasmodia resembling Myxomycetes, and connected with the development of true Gregarines. Real phenomena of motion have not however been observed by the author in these protoplasmic structures. A further argument against their Gregarine nature is the presence in them of a yellow pigment of various shades, pigment of which kind is frequently found in the Myxomycetes.

To what was known of the formation of the spores of the true Psorospermiæ which occur within the protoplasmic structures, Gabriel is hardly able to add anything. According to him, the spores are developed, as already stated by Leydig and Lieberkühn, in spaces or vacuoles which are at first unprovided with walls, and later, but not in all cases, become converted into vesicles by formation of a wall. The spores are formed within these vacuoles in a manner which is compared by the author to a process of secretion. Inasmuch as several spores may develope within a single vacuole, Gabriel terms the vacuoles "polysporogenetic centres of development," and sees in them a veritable contrast to the "single, monosporogenetic forms of

* Ber. naturw. Sect. Schles. Ges., 1879, pp. 26–33. Cf. Zool. Jahresber. Neapel for 1880, i. pp. 162–4.

† Op. cit., p. 162.

development" of the Gregarine germs (Pseudonavicellæ). Of the structure of the spores we learn almost nothing; in particular, the remarkable thread-cell-like structure of the so-called polar corpuscles appears to have quite escaped the author, and he takes no notice at all of Balbiani's work on the Psorospermiæ of fish. He has not been able to observe any bursting of the spores and emission of an amœboid body.

On the other hand, he has observed a method of development of the spores which is carried out inside the bladder, but which he gives with some reserve. It commences with the solution and absorption of the containing capsule, but then proceeds in two different ways. Either the central protoplasmic part of the spore fuses with the two polar corpuscles into a single protoplasmic mass, or the parts remain distinct. In the latter case the spore-contents are said to break up (in a manner which is not very intelligible) into two pieces, seldom more. Finally, spore-contents, which have become granular and vacuolated, are said to develope small, strongly granular plasmodia, which become the protoplasmic structures first described. The existence of another process of spore-development appears to the author to be certain, seeing that at some time or another infection must take place from outside. As already indicated, the author draws from his results the conclusion that the structures which we have been considering cannot be included with the Gregarinæ, but must be considered as "spore-forming Myxomycetoid plasmodia," not, however, exhibiting the entire characters of the group Myxomycetes. Hence they are to be regarded as a tribe whose systematic position lies between the Myxomycetes and Gregarines, a circumstance which appears to the author to have a most important bearing on the relations which he represents to exist between these two groups.

Morphology of Protozoa.—L. Maggi * again calls attention to the differentiation of a mesoplasm between the ecto- and endoplasm, a fact of deep importance in his view, and first discovered by him in certain Amœbæ and the genus *Podostoma*. The demarcation of these three regions in the protoplasm of the body of certain Protozoa appears to him of especial interest for this reason, that they exhibit an analogy with the three blastodermic layers of the Metazoa. The ectoplasm gives rise to the pseudopodia, which effect the relations with the outer world; on the other hand, the mesoplasm supplies the contractile vacuole, an organ of circulation, excretion, and exhalation; lastly, the entoplasm contains the "entoplasmatic organs," viz. the digestive cavity, the nucleus, and nucleolus, the two last being the organs of reproduction. Thus it is the mesoplasm and entoplasm which support the vegetative functions of life. Grimm also † has pronounced in favour of the view of the differentiation of a mesoplasm and drawn the same parallel with the germinal layers of the Metazoa.

G. Cattaneo ‡ expresses opinions with regard to the morphological

* Bollet. Scientif., i. (1880) pp. 81–3. Cf. Zool. Jahresber. Neapel for 1880, i. p. 123.

† 'Contributions to the Knowledge of the Simplest Animals,' 1877, in Russian.

‡ Atti Soc. Ital. Sci. Nat., xxii. (1880) p. 68 (2 pls.). Cf. Zool. Jahresber. Neapel, tom. cit., p. 123.

structure of plastids precisely similar to those propounded in 1879 by Maggi. In his view the protoplasm and plasson are made up of numerous simple albuminoid particles, which he agrees with Maggi in naming *plastidules* and which represent the simplest morphological elements. The simplest forms of these plastidules, the so-called *protoplastidules*, are said to be the granules devoid of independent motion which are found in organic infusions; with these may perhaps be ranked as structures of similar morphological value, the free solitary spherical Bacteria, the Cocci, and Micrococci. If these protoplastidules become differentiated in such a way as to form around themselves parts of unequal physiological values, there arise the *autoplastidules*, among which must be included the simple Microbacteria, such as *Bacterium termo*, the Monococci and Monobacteria of Billroth, the Desmobacteria (*Bacillus*), and the Spirobacteria (*Spirillum*). By colonial growth, on the other hand, the protoplastidules give rise to *symplastidules*, among which are placed the social forms of the Bacteria, as the Diplobacteria, the Strepto-, Glio-, and Petalobacteria, and also the Amphiasters (*Kernspindeln*), and stellate figures of cells in process of division. A combination of plastidules which are not all developed in the same way forms a *plastid*.

Differentiation generally takes place in a radiating manner, so that an outer and an inner mass are formed, differing somewhat from each other. The simpler forms are in this case the *protoplastids*, which include the non-nucleate gymno- and lepo-cytodes, and the simpler nucleate gymno- and lepo-cellulæ. By further differentiation these protoplastids result in *autoplastids*. The author considers that the different layers of differentiated substance in a highly developed autoplastid, viz. ecto-, meso-, entoplasm, nucleus, and nucleolus, may be compared to so many cytodes concentrically grouped; and thus an autoplastid of this kind is to be regarded anatomically (though not genetically) as a colony of cytodes.

The colonies of plastids are described as *symplastids*. The author includes among them the Gregarinæ.

Eozoon Canadense.*—Professors King and Rowney deal with the question of the organic nature of *Eozoon* and of simulation of organized structures generally, their opinion being decidedly in favour of its mineral origin.

In the first place they state that the "typical nummuline wall" is a pectinated form of chrysolite, due to modification of that allomorph of serpentine, where the fibres of the mineral ultimately become separated aciculæ with calcareous interpolations. The "canal system, &c.," is rather more obscure in its origin. It is frequently due to the peculiarities of a layer of flocculite (a non-fibrous allomorph of serpentine), which on undergoing some solvent or decreting process, is apt to be shaped into irregular configurations. So likewise the "chamber castes" of the acervuline variety are identical with the variously lobulated crystalloids characteristic of

* King and Rowney, 'An Old Chapter in the Geological Record with a New Interpretation; or, Rock Metamorphism and its Resultant Imitation of Organisms.' 8vo, Van Voorst, 1881. See Geol. Mag., ix. (1882) pp. 231–6.

Tyree "marble" and similar rocks, due, as the authors believe, to decretion of the original silicate. As regards the calcitic layer containing the "intermediate skeleton" in typical specimens of *Eozoon*, the calcite composing this part is "plainly a replacement pseudomorph after serpentine." This explanation would account for the alleged cases of "chambers" and "canal system" preserved in calcite.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Chemical Difference between Dead and Living Protoplasm.—In the paper by Dr. O. Loew and T. Bokorny, noticed under the above heading at vol. i. (1881), pp. 906–7, it should have been stated in the description of the method employed for producing the reduction of silver by the protoplasm, that the silver nitrate solution must be used in an alkaline condition, produced by the addition of ammonia. Similarly, to obtain reactions with gold chloride and platinum chloride respectively, the previous addition of caustic soda to the solution of the salt is necessary.

Dr. Loew describes the preparation of the silver solution as follows:—(*a*) Prepare a 1 per cent. solution of nitrate of silver; (*b*) mix 13 cc. of a solution of potash (1·33 sp. gr.) with 10 cc. of caustic ammonia (1·96 sp. gr.), and dilute with water to 100 cc. Mix 1 cc. of each of (*a*) and (*b*) and dilute the 2 cc. to 1 litre immediately before use.

Occurrence of Aldehydes in Chlorophyllaceous Plants.*—J. Reinke and Krätschmar assert the presence of volatile reducing substances in all the chlorophyllaceous groups of plants; in algæ, lichens, mosses, ferns, conifers, and angiosperms; while they are absent from fungi and etiolated seedlings of flowering plants. Their occurrence appears therefore to be connected with the presence of chlorophyll, though they may spread to the parts which do not contain this substance. The authors determined the presence of two such substances of different reducing powers. From the powerful reducing properties, it is inferred that these substances belong to the class of aldehydes; and their power of reducing a neutral silver solution in the cold appears to identify them with formic aldehyde. If this should not be confirmed, they may possibly be identical with acetol or with some other "ceton-alcohol."

Organ not hitherto described in the Vegetable Embryo.†—G. Briosi describes a part of the embryo which he finds in some plants, and which has hitherto escaped attention. If the exalbuminous

* Berichte deutsch. chem Ges., xiv. (1881) p. 2144. See Bot. Ztg., xl. (1882) p. 57.

† G. Briosi, Sopra un organo finora non avvertito di alcuni embrioni vegetali. 15 pp. (3 pls.) Rome, 1882.

seed of *Eucalyptus globulus* is carefully examined, the embryo is seen to consist of two cotyledons and a radicle without plumule; but the radicle is found not to be of very simple structure. It is not perfectly cylindrical, but its lower extremity is somewhat club-shaped. A longitudinal section shows that its central portion is composed mainly of the tigellum or hypocotyl, surrounded near its lower extremity by a kind of collar through which the radicle projects. This collar is composed entirely of parenchymatous tissue containing no fibro-vascular bundle, and is completely covered with white hairs. As the seed germinates it developes to a considerable size, but finally disappears, leaving not a trace behind. The author believes that it is endowed with a nutritive function. He has observed it in the embryo of several genera of Myrtaceæ, also in Onagrarieæ and Lythrarieæ.

Studies of Protoplasm.*—In a series of papers under this title, J. Reinke proposes to classify the substances out of which protoplasm is composed under the three heads of "constant," "variable," and "accessory."

The author regards the first product of the assimilation of carbonic acid as probably formic aldehyde, according to the equation $CO_3H_2 - 2O = COH_2$. From this various polymeric substances are then produced, as, for example, grape-sugar, $6\ CH_2O = C_6H_{12}O_6$. The author distilled leaves of the poplar, willow, and vine with water, and reduced the distillate by Fehling's solution and solution of silver nitrate, by which the presence of an aldehyde-like substance was determined. The same result was obtained from roots of the willow, and with leaves which had remained for eight days in the dark.

Composition of the Protoplasm of Æthalium septicum.†—In continuation of previous investigations,‡ J. Reinke and H. Rodewald give fresh analyses of the protoplasm of *Æthalium septicum*. The plasmodium has, when fresh, an alkaline reaction. A turbid yellowish fluid, the enchylema, can be obtained by pressure; it contains albuminoids, and can be coagulated at a temperature of 58–64° C. The fresh plasmodium contains 71·6 per cent. of water; the following is an analysis of the ash:—

	Per cent.
Carbonic acid	36·02
Phosphoric acid	6·49
Sulphuric acid	0·42
Chlorine	0·21
Sesquioxide of iron	0·13
Lime	54·34
Oxide of magnesium	0·71
Potassa	1 41
Soda	0·18
	99·92

Extraction of the air-dried substance by ether yields from 5·36 to 8·13 per cent. of extract, which saponifies in alcoholic solution, and

* Unters. aus dem bot. Lab. Göttingen, 1881, pp. 74–184, 187–202.
† Ibid., pp. 1–75. See Bot. Centralbl., viii. (1881) p. 292.
‡ See this Journal, i. (1881) pp. 283, 918.

yields about 21 per cent. of paracholesterin. The volatile fatty acids found were propionic, butyric, caprionic, and probably caprinic acid, the non-volatile fatty acids, stearic, palmitic, and oleic acids.

The spores contain a larger quantity of asparagin than the protoplasm. The presence of acetic and oxalic acids was certainly, that of lactic acid probably, determined. In perfectly fresh protoplasm, Hoppe-Seyler's method determined the presence of myosin and vitellin; in the glycerin-extract was a ferment (pepsin) with the property of dissolving albumen.

Properties of the Protoplasm in Urtica urens.*—F. Kallen has investigated the phenomena displayed by the protoplasm of the stinging-nettle, in the merismatic cells, the medullary cells, the epidermal cells, the hairs, the glandular hairs, the stinging hairs, the cortical parenchymatous cells, the bast-fibres, the cells of the soft bast, the cambium cells, the wood-vessels, and the prosenchymatous cells. The following are the general results arrived at.

In all the cells the nucleus is densest and largest in comparison to the size of the cell in the youngest stage. In older stages of the parenchymatous cells there is frequent fragmentation; this occurs in the pith, the cortex, and the unthickened wood-parenchyma-cells. The finely punctated protoplasm exhibits at all stages a coarsely reticulate structure, as in the medullary cells; but the interstices are covered by a hyaline layer of protoplasm, so that the protoplasmic utricle is nowhere interrupted. The nucleus does not usually disappear before the protoplasm; in the sieve-tubes only does this take place; while in older stages of the bast-fibres, the nucleus is partially absorbed. In the xylem-vessels the nucleus and protoplasm never disappear. Crystalloids were in a few cases found in the nuclei of the hairs. The multinucleated bast-fibres contain latex. The nuclei of the bast-fibres multiply by fragmentation, not, as Treub supposes, by division.

Fertilization of Salvia splendens.†—W. Trelease describes the "ornithophilous" structure of this Brazilian species, the structure being especially adapted for fertilization by humming-birds. It is proterandrous, and there is no arrangement to facilitate fertilization by either day or night-flying insects.

Reproductive Organs of Loranthaceæ.‡—M. Treub has investigated the development and structure of the sexual organs in this natural order in the case of *Loranthus sphærocarpus*. The rudimentary carpels enclose a small cavity, in the middle of which rises a hemispherical central papilla, an elongation of the axis. This papilla is so connected with the carpels that only three or four canals remain open, and these also soon disappear. Before this complete union is effected, there can be detected in each free lobe of the central papilla hypodermal cells of larger size, which soon assume a nearly vertical

* Flora, lxv. (1882) pp. 65–80, 81–92, 97–105 (1 pl.).
† Amer. Natural., xv. (1881) pp. 265–9.
‡ Ann. Jard. bot. Buitenzorg (Java), ii. (1881) pp. 54–76 (8 pls.). See Bot. Ztg., xl. (1882) p. 59.

position, and divide, by transverse septa, into three superposed cells. Of the four or five rows of cells thus formed, the uppermost daughter-cell of one only developes, and becomes the embryo-sac; all the rest are resorbed, including the two belonging to the same row. Since each of the originally free lobes from the central papilla forms an embryo-sac, and the number of these lobes corresponds to that of the carpels, the number of embryo-sacs in the ovary also corresponds to that of the carpels. Round the embryo-sac is formed, partly out of the previous epidermal cells of the central papilla, a sheath of amylaceous cells, which is prolonged upwards into a similar row, while in the lower part of the ovary is developed a sheath of collenchymatous tissue open above. The embryo-sacs elongate to an extraordinary extent both upwards and downwards, following upwards the row of amylaceous cells till they reach the base of the style, and there somewhat expand; while they extend downwards to the base of the collenchymatous sheath. Their nucleus now divides; one of the daughter-nuclei moves into the upper expanded portion of the sac and again divides.

The first wall in the fertilized germinal cell is longitudinal, followed in each half by several transverse septa. The lower cells of this suspensor divide further, while the upper ones grow to an extraordinary length, and force the lower apex of the embryo between the first endosperm-cells, which have at the same time been formed in the lower part of the embryo-sac; the embryo being thus finally attached to the end of the double thread which constitutes the suspensor, and which is rolled up between the embryo and the endosperm. The endosperm cells now increase rapidly in number in its lower and peripheral parts, thus crushing the suspensor, which finally entirely disappears. The radicular end of the embryo then penetrates into the endosperm and consumes it; and the embryo becomes completely enclosed in the collenchymatous sheath; rising up into it, partly in consequence of the pressure of the lower part of the endosperm.

The central papilla formed in the centre of the ovarian cavity was regarded by Griffith as a placenta with rudimentary ovules; by Hofmeister as an orthotropous nucleus without integuments, in which several embryo-sacs are formed, and the chalaza of which is represented by the collenchymatous sheath. Treub supports the former view, and considers the axial portion of the papilla to be of the nature of a placenta, its three or four lobes being rudimentary ovules; a view confirmed by the somewhat similar structure presented by the Santalaceæ. Griffith thought that the single embryo was the result of the coalescence of several; Treub is unable to confirm this; but, on the other hand, found frequent evidence of the abortion of embryos, one only of which reaches maturity.

Structure and Mode of Formation of Spermatozoids.*—E. Zacharias has investigated the behaviour with different reagents of the various constituents of spermatozoids, chiefly those of *Nitella*

* Bot. Ztg., xxxix. (1881) pp. 827–38, 846–52.

syncarpa and *Chara aspera*. The spermatozoid he regards as composed of three parts—the spiral band, the paler terminal portion or vesicle, and the cilia.

A solution of pepsin does not dissolve the spiral band; it becomes, on the contrary, more distinct and strongly refractive, either retaining altogether its original form, or becoming more or less short and thick; the separate coils sometimes coalesce into a single homogeneous refractive lump. The cilia are almost completely dissolved, while the posterior vesicle swells up, and finally again contracts. A dilute solution of sodium chloride causes the spiral band to swell up slowly, a peripheral denser part becoming differentiated from a central less dense part; the latter finally dissolves entirely, the former only being left in the form of a fine pellicle, which contracts and is coloured brown by a solution of iodine in potassium iodide. The posterior vesicle swells up, and then again contracts. The cilia do not contract, and are affected only by concentrated hydrochloric acid. The reactions with pepsin are also described in detail.

The spermatozoids of Muscineæ (*Fegatella* and *Lunularia*) agree in their behaviour, in all important points, with those of the Characeæ. Those of ferns and of *Marsilea* differ in some particulars. The spiral bands of the spermatozoids of an Australian *Marsilea* were distinguished by their extraordinary resistance to solvents, as was also the case with those of some ferns (*Hemitelia capensis*); while the cilia agreed in their properties with those of the Characeæ.

The author then compares the properties and reactions of the spermatozoids of cryptogams with those of the spermatozoids of animals, as investigated by Miescher, Schweiger-Seidel, Flemming, and others, and finds that in many respects the properties of the cilia and spiral bands of cryptogams agree respectively with those of the tail and head of animal spermatozoids. A similar relationship is found in the development of the different parts in spermatozoids belonging to the two kingdoms.

As regards the history of development of the spermatozoids of *Chara* and *Nitella*, the nuclei of the young mother-cells are composed of parts of various refrangibility, and each nucleus contains a nucleolus. The peripheral layer of the nucleus subsequently becomes denser, and the central part less dense. The nuclei at this time approach the outer wall of the cell, the rest of the protoplasm collecting at the opposite side. From the peripheral layer is formed the spiral band of the spermatozoid. The author was unable to decide whether the nucleolus takes any part in the formation of the spermatozoid, or whether the cilia are formed out of the nucleus, or, as Schmitz states, out of the cell-protoplasm.

The author considers that both the course of development and the chemical reactions indicate that in all probability the head of animal and the spiral band of vegetable spermatozoids owe the nuclei which they contain to the fact that they are formed from the nucleus of the mother-cell; while, on the other hand, the tail of animal and the cilia of vegetable spermatozoids are formed out of the cell-protoplasm.

Cell-nucleus in the Mother-cells of the Pollen of Liliaceæ.*— Investigations on this point have been carried out by A. Lalewski, mostly on *Lilium candidum* and *Allium Moly*. His mode of preparation was to place transverse sections of the young stamens in a 1 per cent. solution of acetic acid, slightly coloured by methyl-green. After a time, the nucleus acquires a beautiful blue colour, while the remaining contents of the cell continue nearly or quite colourless.

The large and fully developed cell-nucleus of *Lilium candidum* is enclosed, not in a pellicle of denser nuclear substance, but in an extremely delicate coat of cellulose. Immediately beneath the surface it usually contains a finely granular semi-transparent nucleolus, which is not coloured by methyl-green, and which remains unchanged up to a certain period in the division of the nucleus. After the initial stages, the membrane of the nucleus is resorbed, the vermiform structures which had been formed become straight, and place themselves in the equatorial region in the longitudinal axis of the cell, and, after completely coalescing at the poles, constitute the well-known "nuclear spindle." According to the author, the vermiform constituents of the nucleus are also enclosed in an exceedingly delicate coat or sac of cellulose, filled with dense protoplasm, which draws towards the equator, while the empty ends of the sacs become elongated, finally meeting and coalescing at the poles of the nucleus. Hence the number of nuclear or spindle-threads is normally the same as that of the elements of the nuclear plate. When the number of threads is larger than that of the elements of the nuclear plate, this is due to the protoplasm of some of the smaller elements of the plate being entirely used up in the formation of spindles. This stage is shortly followed by the splitting of the nuclear plate, which usually takes place by the protoplasm of the elements of the plate beginning to move in opposite directions towards the two poles, and thus assuming an elongated form. Reaching the wall of the cell, these strings of protoplasm coalesce in pairs into a V-shaped structure. The nucleoli, which have up to this point remained unchanged, now take part in the further changes in the cell. They move towards the middle of the cell, break up into smaller portions, and form in this manner both the protoplasm of the cell, which is compressed from all sides at the plate, and the material for forming the cell-plate. At the line of contact of the plate with the cell-wall of the mother-cell, the young cell-wall first appears in the form of a ring, which quickly grows inwards, and finally developes into a perfectly continuous division-wall. In the daughter-cells thus formed the nuclei divide in just the same way as in the mother-cell.

Crystalloids in the Cell-nuclei of Pinguicula and Utricularia.†— According to further observations of J. Klein, the crystalloids found in the cell-nucleus of these two plants strongly resemble not only one another, but also those found in *Lathræa squamaria*, a point of interest from the fact that Eichler advocates a closer genetic relation-

* Kosmos, 1881, pp. 158–74 (1 pl.). See Bot. Centralbl., viii (1881) p. 375.
† Pringsheim's Jahrb. für wiss. Bot., xiii. (1881) pp. 60–73 (1 pl.). Cf. this Journal, i. (1881) p. 477.

ship between this species and the two former than has generally been supposed. This resemblance relates not only to their form, but also to their chemical properties. They differ from ordinary proteinaceous crystalloids in being more soluble in water and in the cell-sap of dead cells. *Utricularia vulgaris* contains also crystals of calcium oxalate of regular octahedral form, but occasionally of a peculiar stellate or rod-like shape.

Cystoliths in Momordica.*—The occurrence of cystoliths has been at present determined only in the Urticaceæ and allied orders and in the Acanthaceæ and Cucurbitaceæ. Dr. O. Penzig now finds them in several species of *Momordica* (Cucurbitaceæ), especially *M. Charantia* and *echinata*. They occur almost exclusively in the leaves; in some instances also in the bracts. Their location is entirely in the lower layers of the epidermis (hypophyll); they are always attached to the radial lateral walls of the cell, presenting in this point a contrast to those of *Ficus*. They are never solitary, but always two or more in a corresponding number of adjoining cells.

In *Momordica echinata* the cystoliths are almost always in pairs, and they spring in adjoining cells from opposite points of the same wall. In the earliest stages of the leaf the cells of the hypophyll are all precisely alike. The mother-cells of the cystoliths then become distinguished by their larger size and more strongly refractive cell-contents. When they have attained about four times the size of the ordinary cells, they divide by an anticlinal division-wall, and the two cells thus formed may divide further or not. At a later period the mother-cells of the cystoliths are entirely destitute of chlorophyll and starch, containing only abundant protoplasm. A small protuberance of cellulose then appears on each side of the partition-wall, which developes into a cylindrical or club shape; and it is only when nearly fully developed that the deposition of calcium carbonate takes place in it. The mature cystolith always has, as in the Urticaceæ, somewhat the appearance of a bunch of grapes.

In *M. Charantia* usually three, four, or five contiguous cells produce cystoliths, one in each, and they then spring all from a common central angle; but eventually their base widens out, so as almost entirely to fill up the cells. The same process then infects a number of adjoining cells, so that eventually a large and complicated mass is formed, occupying a large number of the cells of the epidermis.

When the lime is removed by weak acetic acid, a slight skeleton remains, which is coloured dark yellow, passing into brown, by iodine solution or chlor-iodide of zinc. The cellulose reaction can, however, be obtained from it with care, and it probably consists of impure cellulose.

Sphero-crystals.†—J. Schaarschmidt has detected organic sphero-crystals in four natural orders of flowering plants in which they have not previously been observed, viz. Euphorbiaceæ (*Euphorbia*), Rutaceæ

* Bot. Centralbl., viii. (1881) pp. 393–400 (3 pls.).

† Magyar Novénytani Lapok, v. (1881) pp. 134–8. See Bot. Centralbl., ix. (1882) p. 46.

(*Haplophyllum*), Urticaceæ (*Urtica*), and Palmæ (*Nunnezharia* and *Phœnix*).

In *Euphorbia Tirucalli* they are unusually beautifully developed. In an early stage a centre of formation may be observed, which may be a chlorophyll- or starch-grain; round this is formed a massive nucleus, to which the crystals are attached with a radiate arrangement. Subsequently they exhibit evident stratification. The radiate portion is at first colourless, afterwards yellowish brown; the whole is evidently crystalline. The sphero-crystals are usually readily soluble in cold water; their behaviour towards reagents is similar to that of inulin.

In *Urtica major* the sphero-crystals are found in the guard-cells of the stomata and neighbouring cells, less often in the fundamental tissue. They are dark brown, insoluble in cold or in boiling water, and appear allied in their nature to hesperidin.

In *Nunnezharia* they occur in the peripheral fundamental tissue of the stem, forming large yellow clusters, also in the leaves, bracts, and rachis of the inflorescence. They are slowly soluble in cold water, and exhibit the closest resemblance to inulin.

Structure of Starch-grains.*—A. Meyer discusses Nägeli's theory of the formation of starch-grains by intussusception, and A. F. W. Schimper's † that they are sphero-crystalloids of a carbohydrate formed by apposition of concentric layers; and argues in favour of the latter, from the similarity of the phenomena they present to those of artificially prepared sphero-crystals of a carbohydrate such as sugar. In these the three following characters are found, which agree with those of starch-grains:—(1) Variations in the external conditions which affect crystallization cause also the formation of layers; (2) the centre of crystallization is less dense than the surrounding layers; (3) the youngest external layer is the densest, the density of the successive layers towards the interior decreasing with their age.

A full description follows of the starch and starch-generators in the rhizome of *Iris pallida* and *germanica*, the following being the general conclusions arrived at:—(1) The starch-generators in the rhizome of *Iris* only perish with the death of the cells in which they are found; (2) in them not only the formation but the solution of starch-grains takes place; (3) both internal and external solution of the starch-grains takes place in the cells; (4) the only simple explanation of all the phenomena observed is presented by the hypothesis that the starch-grains increase in substance by apposition.

Assimilating Tissue.‡—G. Haberlandt supports the view of Schwendener that the structure and arrangement of the cells which constitute the assimilating tissue are dependent on the process of assimilation. The more important cell-forms of which it is composed may be classified as follows:—

* Bot. Ztg., xxxix. (1881) pp. 841–6, 857–64 (1 pl.).
† See this Journal, i. (1881) pp. 481, 909.
‡ Pringsheim's Jahrb. für wiss. Bot., xiii. (1881) pp. 74–188 (6 pls.). Cf. this Journal, i. (1881) p. 912.

1. Elongated cells of tubular and cylindrical, rarely prismatic shape. Their position in relation to the surface of the assimilating organ varies. Most commonly they are vertical, in which case they are termed *palisade-cells*, less often parallel to the surface. When provided with arms or protuberances, they may be called *branched palisade-cells*; *funnel-cells*, when the end nearest the surface is of larger diameter than the other end.

2. *Tabular polyhedral cells*, with or without infoldings of the wall.

3. *Isodiametric cells*, with a tendency to rounding.

4. *Spongy parenchymatous-cells*, of stellate form and much branched.

The cell-walls are sometimes furnished with simple pits, and are usually thin and delicate. The chlorophyll-grains are as a rule from two to six times more numerous in the palisade-tissue than in the spongy parenchyma, from which the writer infers that the former is in an especial manner the assimilating tissue of plants. The assimilating cells frequently show infoldings of the cell-walls, as in *Pinus*, the object being to increase the surface of cell-wall, and thus provide room for a larger number of chlorophyll-grains. These folds are so arranged as to facilitate to the greatest possible extent the abduction of the products of assimilation.

Dependent on the characters already mentioned, the author classifies the various forms of assimilating tissue under ten types, arranged under the following heads:—(1) The assimilating tissue serves also as an abducting tissue. (2) Both these kinds of tissue are present, the products of assimilation passing out of the former into the latter. (3) Besides these two kinds there is also a special conducting tissue, through which the products pass in their way from the assimilating to the abducting tissue.

The spongy parenchyma subserves three distinct physiological functions:—(1) It is peculiarly the transpiring tissue of the leaf. (2) It is the conducting tissue. (3) In consequence of the larger or smaller quantity of chlorophyll which it contains, it is an assimilating tissue.

Light, which is the most important external factor in assimilation, while exercising a powerful influence on the arrangement of the assimilating system, scarcely affects its anatomical structure. It occasions the peripheral position of the special assimilating cells, and, in dorsiventral organs, their production on the illuminated side. The frequent occurrence of palisade-tissue is explained by the fact that the position of elongated cells at right angles to the surface of the organ favours the complete and intense illumination of the organ.

Every assimilating cell adjoins, at some part of its walls, the aerating system or intercellular spaces, which also serve to prevent the passing of the products of assimilation in unadvantageous directions.

The firmness of the assimilating tissue is secured by a variety of contrivances; as the thickening of the walls of the palisade-tissue in some species of *Cycas*, the columnar cells in *Hakea*, and the frequent occurrence of branched sclerenchymatous cells among the green cells.

There are often found cells and tissues which serve purposes of local assimilation, as glandular and stinging hairs, the guard-cells of stomata, &c.

The origin of the assimilating tissue varies greatly. It may arise from the cambium, the fundamental parenchyma, or the young epidermis.

The fundamental parenchyma of the stem passes without interruption into the parenchyma of the leaf-stalk, which is itself in connection with the parenchymatous sheaths of the vascular bundles of the leaf; this entire system forming the principal channel for the passage of the products of assimilation.

In addition to its primary function, the assimilating system of many evergreen leaves, as those of conifers, fulfils a secondary function, viz. the storing up of the products of assimilation during the period of repose.

Fibrovascular Bundles of Monocotyledons.*—The fibrovascular bundles of Monocotyledons are normally of two kinds, collateral, in which the xylem and phloëm run side by side, and concentric, in which a ring of xylem, usually closed on all sides, encloses a central mass of phloëm. L. Kny points out that not a few monocotyledons possess fibrovascular bundles which do not correspond to either of these types. Not unfrequently two or more groups of soft bast are separated by masses of sclerenchyma. In a number of palms bipartition of the phloëm occurs, and in *Rhapis flabelliformis* tripartition is the rule. Sclerenchyma frequently forces its way from both sides between the phloëm and xylem, separating them from one another. In *Testudinaria* and other Dioscoreaceæ the separation of the phloëm into two distinct groups is especially marked. The object both of this separation and of the interposition of sclerenchyma, the author believes to be the mechanical strength gained thereby.

Sieve-Tubes.†—E. Janczewski continues his researches ‡ on the sieve-tubes of Dicotyledons, with especial reference to *Aristolochia Sipho*, *Tilia parvifolia*, and *Vitis vinifera*.

They may be formed out of cambium-cells in two different ways:—(1) The cambium-cell, after detaching derivative cells on each side, developes the sieve-tube-cell directly; and the sieve-tubes are then arranged in radial rows, in contact with one another by their tangential walls; or (2) the cambium-cell divides longitudinally and tangentially into two cells of unequal size, of which the outer and larger one becomes the sieve-tube-cell either immediately or after the separation of lateral derivative cells, while the inner and smaller cell breaks up, by transverse division, into a row of parenchymatous cells. In this latter case they are separated from one another, and can touch one another only by their radial walls. A single cambium-cell

* Verhandl. bot. Ver. Prov. Brandenburg, xxii. (1881) pp. 94–109. See Bot. Centralbl., ix. (1882) p. 79.

† SB. Akad. Wiss. Krakau, ix. (1881) (5 pls.). See Bot. Centralbl., ix. (1882) p. 15.

‡ See this Journal, iii. (1880) p. 824.

will sometimes produce from two to four sieve-tube-cells by transverse division, and production of sieve-plates on the transverse walls.

The formation of sieve-plates commences with the development of symmetrical callus-warts on both sides of the terminal surfaces of the cell; the portions of cell-wall between these retain permanently their original chemical constitution, and form the future cellulose-sieve of the sieve-plate. A little later the callus-warts coalesce into a uniform mass covering the cellulose-sieve, in which perforations appear in place of the previous warts, causing a direct communication between the contents of adjoining sieve-tube-cells.

The period of existence of the sieve-tube may be divided, in relation to its physiological function, into three epochs. The first is the active period, characterized by the open sieve-plates covered with callus, the parietal layer of protoplasm in the tubes, and the formation within them of mucilage and sometimes also of starch-grains. In the second or transition period the tubes lose their contents, and the sieve-plate is covered by a homogeneous mass of callus, which soon begins to become absorbed. The third or passive period relates to those sieve-tubes the plates of which are again opened, but consist simply of a cellulose-sieve without any deposit of callus; the contents have either entirely disappeared, or are often reduced to a small quantity of mucilage, and the sieve-tubes can then at most only serve for the transport of watery fluids. The relative length of these different periods varies greatly in different plants.

The author finally examines the structure of the sieve-tubes of Monocotyledons, especially *Typha latifolia* and *Phragmites communis.* In the rhizomes of *Phragmites* the young sieve-tubes are developed out of the procambial cells, which first divide by tangential walls into two cells of unequal size; the outer and larger of these developes immediately into the sieve-tube-cell, while the inner and smaller one divides, by a number of transverse and radial divisions, into cambiform. The young sieve-tube is at first distinguished from the neighbouring procambial and young cambiform cells only by its larger dimensions, and by having lost its power of division. But soon the lateral walls thicken, and dots appear in them, and at the same time wart-like prominences on the terminal wall, which are at first small and are composed of pure cellulose, but gradually increase in size and assume a callose character. The subsequent processes resemble those in Dicotyledons.

A great difference is observable between the behaviour of the sieve-tubes in Monocotyledons and Dicotyledons. In the latter, after having once become passive, they are constantly replaced by the activity of the cambium, and therefore endure only for a few months, or at most a few years; in the former, in consequence of the absence of cambium, the activity of the tubes lasts much longer, in fact, as a rule, as long as the organ itself in which they are found.

The author concludes with the following general remarks. The elements of the sieve-tubes are always and everywhere prismatic, and are either horizontal or sharply truncate at the extremities. Their walls are always composed of pure cellulose, and are never strongly

thickened. They are never entirely homogeneous, but are furnished with a larger or smaller number of dots, which in some cases always remain closed, as in Vascular Cryptogams, in others are at an early period covered with callose substance, being shortly afterwards changed into a true sieve by the appearance of numerous perforations, as in Phanerogams. The mature sieve-tube never contains a nucleus, having only a thin parietal layer of protoplasm which marks its vitality, and which entirely disappears with the death of the organ on the cessation of the life of the sieve-tube.

Structure and Functions of Stomata.*—A. Tschirch distinguishes the following distinct parts of the stomatal apparatus:—(1) The eisodial opening, or opening into the anterior chamber; (2) The opisthodial opening, or opening into the posterior chamber; (3) The central fissure; the true fissure between the two openings, which separates the guard-cells; (4) The outer and inner cuticular ridges, which are often circular and surround the two openings; (5) The outer stoma, or outer space which causes the depression in depressed stomata; (6) The circular wall, or margin which projects above the epidermis when the depression is pitcher-shaped; (7) The circular ridges when the stoma is funnel-shaped; and (8) The epidermal opening, or actual orifice of the outer stoma.

The author classifies the different forms of stomatal apparatus under eighteen types, which are described in detail.

Excessive evaporation is prevented, firstly by the form of the stomata themselves; and secondly, by various special contrivances for the purpose, as the structure of the epidermis and accumulation in it of incrustation of calcium oxalate; coatings of wax on the epidermis; hairy formations; limitation of the large intercellular spaces in the merenchyma of the leaf; the nature of the cell-sap; and the form and (frequently vertical) position of the leaves.

The number of stomata on a unit of surface in nearly related plants is larger in those which grow in moist, smaller in those which grow in dry habitats. The arrangement of the stomata is associated with purposes of protection. In those leaves which roll up when dry, the stomata on the concave side are enclosed; and the same is the case in grasses which grow in dry situations.

Stomata of Stapelia.†—J. Jákó describes the structure of the complicated stomata of *Stapelia variegata* and *trifida*, which presents considerable analogy to that in many Monocotyledons, especially *Tradescantia* and *Commelyna*.

Influences of External Forces on the Direction of Growth.‡—Sachs attributes the direction taken by pollen-tubes, after the grains attach themselves to the stigmatic papillæ, down the style, to the arrest of growth on the side in contact with the solid substance; Darwin, to the endeavour to avoid the light. L. Kny has attempted

* Linnæa, xliii. (1881) pp. 139–252 (1 pl.).
† Magyar Novényt. Lapok, v. (1881) pp. 151–6.
‡ SB. Bot. Vereins Prov. Brandenburg, xxiii. (1881). See Bot. Centralbl., ix. (1882) p. 10.

to determine this question experimentally, by immersing pollen-grains in a mixture of gelatine (first warmed) and a solution of sugar, with a very small quantity of extract of meat, in which nutrient fluid they readily put out their tubes. He finds that neither the spot to which the pollen-tube attaches itself, nor the direction which it afterwards takes, nor the rapidity of its growth, is in any way affected either by gravitation or by light, or by contact with a solid substance. Similar experiments on four fungi, *Mucor Mucedo*, *M. stolonifer*, *Trichothecium roseum*, and *Eurotium repens*, yielded similar results as far as gravitation was concerned, this force appearing to exercise no influence on the direction or rapidity of growth of the mycelial filaments, nor on their branching.

Water Distribution in Plants.*—G. Kraus having expressed and filtered the sap of *Lonicera tartarica* and *Datura*, and taken the specific gravity with the usual precautions, found it varied between 1·03 and 1·0059. The juice of sugar-beets ranged between 1·057 and 1·074. The specific gravity of the sap in the growing twig was found to be less in the older than in the younger portions, and growth was invariably accompanied by dilution of the sap, owing to constantly increasing absorption of water. The free acids and albumen also decreased in percentage, but increased in actual quantity. The increase in sugar during growth was remarkable; it increased with great rapidity up to a certain point, when it again declined, so that there is a maximum point in sugar contents, which is not at all coincident with the maximum of growth.

An extended series of observations shows that in crooked plants the under or convex side contains sap of less concentration, and poorer in free acid and sugar, not only relatively, but absolutely. Horizontal branches are richer in sugar than vertical. When plants are shaken so as to bend their tops towards the ground, an immediate increase of specific gravity in the sap, and an increase of sugar in the under or convex part of the bend takes place, showing that the sugar is in actual process of formation at the time of bending.

Causes of the Movement of Water in Plants.†—J. Boehm adduces experimental evidence in favour of his theory, already published, that the main factor in causing the motion of water in plants is not osmose, but the unequal pressure in different cells caused by the constant variation in the intensity of transpiration.

"Compass-flowers." ‡—E. Stahl gives the results of his experiments with *Lactuca Scariola* and *Silphium laciniatum* for the purpose of ascertaining the conditions which cause their leaves to assume a meridional position. In the case of *Silphium*, the common "Compass-plant" of the Western States of America, the fact that the leaves point in a north and south direction has long been known, but in

* Bied. Centr., 1881, pp. 630–2. Journ. Chem. Soc., xlii. (Abstracts), 1882, p. 327. See also this Journal, iii. (1880) pp. 294–5.

† Bot. Ztg., xxxix. (1881) pp. 801–13, 817–27.

‡ Jen. Zeitschr. f. Naturw., xv. (1881) pp. 381–9 (1 (pl.). Cf. Amer. Journ. Sci., iii. (1882) pp. 159–60.

Lactuca Scariola, although it had been observed that the leaves were often vertical, Stahl was the first to notice that they generally stood in a meridional plane.

In both plants, the peculiar position of the leaves is best seen when they grow in unsheltered places, exposed to bright sunlight; while when crowded together, or growing in the shade, the leaves generally assume the common horizontal position. The leaves of *Lactuca* on the north side of the stem become vertical by a twisting of the petiole, the upper surface of the leaf facing the east. Those on the south side by a similar twisting become vertical with the upper surface facing the west. The leaves on the east and west side of the stem do not exhibit any torsion of the petioles, but they become upright with their upper surfaces approximated to the stem. Stahl took two plants growing in pots, and placed one where it would be exposed to direct sunlight from 10 o'clock until 3, and kept in the dark for the rest of the day; the other was placed so that from sunrise until 10 o'clock, and from 3 o'clock until sunset, it was exposed to the sunlight, but from 10 to 3 was in the dark. In the first case the leaves did not assume a meridional position, but in the second case they did.

That the meridional position is produced by the sun when near the horizon is clearly shown by the following experiment:—A pot with several young plants was placed in a window facing the north, where the plants received direct sunlight a few hours after sunrise and before sunset. In this experiment the leaves bent towards the north with their upper surfaces turning either to the east or to the west. The pot was then placed farther back in the room, so that the plants were not exposed to the direct sunlight, and the leaves then assumed a position at right angles to the diffused light from the window. Stahl concludes that the meridional position of the leaves of *Lactuca Scariola* is due to the common diaheliotropism observed in most leaves, and that these leaves differ from those of other plants only in their greater sensitiveness to intense light. In *Silphium* there is a torsion of the petioles as in *Lactuca;* and if the petioles are fastened so that they cannot bend, the blade of the leaf itself twists. Stahl states that a meridional position of the leaves can be seen clearly in *Aplopappus rubiginosus*, and to some extent also in *Lactuca saligna* and *Chondrella juncea*, and he believes that many other examples will be found, especially among the plants of dry and exposed regions.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Relation of Nutrition to the Distribution of the Sexual Organs on the Prothallium of Ferns.*—K. Prantl has made a series of experiments on the influence of different nutrient solutions on the development of the sexual organs on the prothallium of ferns, especially *Osmunda regalis* and *Ceratopteris thalictroides*. The following are the principal results at which he has arrived:—1. A deficiency of nitrogen

* Bot. Ztg., xxxix. (1881) pp. 753-8, 770-6.

is prejudicial to the formation of meristem; 2. Access of nitrogen will induce an amerismatic prothallium to pass over into a merismatic condition.

The development of the reproductive organs on the prothallium is closely connected with its nutrition. Amerismatic prothallia produce antheridia only, never archegonia; these latter organs being produced only in the neighbourhood of a meristem.

The author regards those prothallia of ferns which produce archegonia only and no antheridia as exhibiting the first step in the advance from the isosporous to the heterosporous Filicineæ.

Cell-division and Development of the Embryo of Isoëtes lacustris.*—Hofmeister formulated the general law that in cell-division each newly formed division-wall stands at right angles to the direction of the preceding most energetic growth. Sachs disputed this view; but Dr. F. Kienitz-Gerloff supports the previous view of Hofmeister, adducing as evidence the following instances:—The processes of division in filaments of *Cladophora*, especially in the formation of lateral branches; the division in the apex of a shoot of *Metzgeria*; the processes in the apical cell of a young rudiment of the sporogonium of *Archidium phascoides*, which divides by walls inclined in two opposite directions; the cone of growth of *Salvinia* exhibiting a similar structure; the breaking up of the apical cell of *Cladostephus*, on the cessation of growth at the apex at the commencement of the dormant season; the development within the apical cell in older prothallia of ferns and in embryos of mosses, which determines the direction of the division-walls; the formation of the cap-cells and of segments in roots with a three-sided pyramidal apical cell; as also in segment-cells generally.

The interior of the macrospore of *Isoëtes lacustris* is occupied by moderately large roundish cells, each having a nucleus; no diaphragm, like that of *Selaginella*, could be detected. Older unfertilized prothallia had from twenty to thirty archegonia. The first division-walls in the embryo divide it into octants. The cotyledon is formed out of the two anterior and upper octants; the first root out of the two posterior and upper ones; the foot out of the four lower octants. The further cell-divisions are followed out in detail.

The examination of the ripe and half-ripe spores is attended with great difficulty; the author has not found any hardening material adequate for obtaining good sections, and at the same time giving sufficient clearness to the preparation. Soaking for a time in glycerine answered for certain purposes.

Muscineæ.

Chemical Composition of Mosses.†—E. Treffner has investigated the chemical composition of several species of moss. He finds the amount of silica always high, and varying but little in different species; the greatest quantity was found in *Funaria*. *Orthotrichum*

* Bot. Ztg., xxxix (1881) pp. 761-70, 785-95 (1 pl.).

† E. Treffner, 'Beiträge zur Chemie der Laubmoose,' 62 pp., Dorpat, 1881. See Bot. Centralbl., ix. (1882) p. 9.

and *Dicranum* are distinguished by containing a large amount of oil. *Mnium* contains 10 per cent. of sugar; the proportion decreases successively in *Climacium*, *Polytrichum*, *Hypnum*, *Dicranum*, *Sphagnum*, *Orthotrichum*, *Schistidium*, and *Ceratodon*. Albumen occurs abundantly in the protoplasmic cells of the leaves; *Ceratodon purpureus* contains 12, *Polytrichum* 5 per cent.; but it is not in a condition serviceable for the nutrition of animals.

Fungi.

Influence of Oxygen on the Development of the Lower Fungi.*—F. Hoppe-Seyler states, as the result of a careful series of experiments, that an excess of oxygen greatly promotes the development of bacteria and micrococci, while it exerts a retarding influence on the production of yeast and true ferments, hindering fermentation by the transformation of the organic substances which ordinarily result from it, by active oxidation, into carbonic acid, water, and ammonia.

Chætomium.†—W. Zopf has followed out the life-history of this ascomycetous fungus, especially in the instance of *C. kunzeanum*. The ascospores germinate readily in saccharine vegetable juices, solution of sugar, decoction of dung, urine, and even in water. In addition to the mycelium formed in the substratum, there is generally an aerial mycelium, often of great luxuriance. The formation of perithecia begins after a few days, commencing in the centre of the mycelium, and advancing centrifugally. They proceed from both the submerged and the aërial mycelium, originating in the form of short erect branches, with dense and strongly refractive contents. The primary hyphæ now branch repeatedly, bending and interlacing, and thus producing a dense ball. No differentiation of ascogenous and enveloping hyphæ can be detected, as in other Ascomycetes. In the centre of this pseudo-parenchymatous mass of hyphæ is formed a hollow, into which the adjoining cells send down tubular septated projections, the "nucleophyses"; this results in the first and most important differentiation, into the peripheral part or perithecial wall and the central portion or nucleus. The nucleophyses, which correspond to the base of the perithecium, now undergo a more energetic development in comparison to the rest, being not only longer, but branching more copiously, forming a pseudo-parenchymatous cushion, on the outermost branches of which, projecting into the perithecium, are produced the asci, and, since all the terminal branches are fertile, there are no paraphyses. The hyphæ which clothe the lateral walls of the perithecium, branch but little, and remain sterile, may be termed "periphyses," those that constitute the ascogenous cushion "ascophyses." The wall of the perithecium becomes differentiated into an outer layer composed of narrow brown cells with slightly thickened walls, and an inner layer composed of thin-walled turgid cells. About the time when the asci are being developed, a mouth is formed

* F. Hoppe-Seyler, 'Ueber die Einwirkung des Sauerstoffs auf Gährungen,' 32 pp., Strassburg, 1881.

† Nova Acta Acad. Leop.-Carol., xlii. (1881) (7 pls.). See Bot. Centralbl., ix. (1882) p. 258.

at the apex of the cavity concealed by a dense funnel-shaped coating of hairs. The spores are produced eight in each ascus; the asci themselves and the periphyses deliquescing into a jelly, the swelling of which forces the numerous spores out through the opening.

If the nutriment is insufficient, small flask-shaped projections are formed on the mycelium, from the swollen ends of which are abstricted ellipsoidal or obovoid cells in basipetal succession; and these conidia may form balls which remain permanently attached to the apex of the sterigmata; but they, as well as those which may be produced on other parts of the mycelium, appear to have lost their power of germination.

Similar results were obtained from other species; but *C. fimeti* has no opening to the perithecium, and *C. bostrychodes* forms no conidia.

With regard to the systematic position of *Chætomium*, it differs from other genera of Ascomycetes, as *Eurotium*, *Erysiphe*, *Penicillium*, *Sordaria*, and *Ascobolus*, in the absence of any distinct differentiation of the rudimentary fructification into ascogenous and enveloping hyphæ, agreeing on this point with *Peziza Fuckeliana* and *Pleospora herbarum*. *Peziza* is, however, a gymnocarpus Discomycete; and from *Pleospora*, *Chætomium* differs in the perithecium originating not as a tissue but as a mass of hyphæ, and in the process of differentiation of the fructification. *Chætomium* must therefore be regarded, like *Pleospora*, as a special type of Pyrenomycetes. Since the Perisporiaceæ have perithecia closed on all sides and without any opening, while *Chætomium* resembles the Sphæriaceæ in having such an opening, it is evident that the boundary line between the Perisporiaceæ and the Sphæriaceæ is not so sharp as has generally been supposed.

Zopf divides the genus into two subgenera:—(1) Euchætomium;—perithecium with terminal tuft of hairs and an opening (*C. spirale*, *murorum*, *pannosum*, *crispatum*, *bostrychodes*, *kunzeanum*, *cuniculorum*, *indicum*, and *elatum*); and (2) Chætomidium:—perithecium without any opening or terminal tuft of hairs; furnished at its base with thick wiry rhizoids (*C. fimeti*). Several of these species are new.

Completoria complens, a Parasite on the Prothallium of Ferns.*—This fungus has been found by Leitgeb on the prothallium of *Pteris cretica* and other ferns, and even, in some cases, on the leaves. It penetrates the host from without in the form of a spherical cell, which attaches itself by a stalk-like prolongation to the outer wall of the cell of the host, occupying about the centre of the cell-cavity. The contents consist of finely granular protoplasm, the wall is extremely delicate, and the pedicel is usually enclosed for half its length in a dark-brown sheath. It then puts out a number of prolongations which penetrate the adjacent cells. The reproductive cells are of two kinds, conidia and resting cells; the formation of zoospores seems probable, but has not yet been observed; the resting spores, which vary in diameter between 18 and 25 μ, are formed especially when the supply of nutriment is insufficient.

* SB. k. Akad. Wiss. Wien, lxxxiv. (1881) (1 pl.). See Bot. Centralbl., viii. (1881) p. 226.

As regards the systematic position of the fungus, Leitgeb considers that it may bear a similar relation to the Peronosporeæ to that of the Chytridiaceæ to the Saprolegnieæ; in both we have degraded forms in which the production of sexual organs has been lost, the resting spores taking their place.

Rehm's Ascomycetes.—This most valuable and important collection of dried ascomycetous fungi has now reached twelve parts, and includes no fewer than 600 species, 281 belonging to the Discomycetes, and 319 to the Pyrenomycetes. Of these 59 of the former and 37 of the latter are new. The most recently published part contains detailed and exact descriptions of all these new species, as well as critical remarks on all the other species already included in the collection.

Destruction of Insects by Yeast.—In 1880 we called attention* to some experiments of Professor H. A. Hagen, of Cambridge, Mass., the results of which showed (he considered) that the yeast fungus entered the body of the insect on which it was sprinkled, and produced a growth fatal to the life of the insect. Professor Lankester, however, at the time pointed out that the more probable explanation was that the yeast fungus itself was innocuous, but that it was a vehicle for such a parasite as "green muscardine" (*Isaria destructor*), which Metschnikoff found was best cultivated by the use of beer-mash.

Mr. T. H. Hart, of Ashford, having tried the application of yeast, reports† to Professor Hagen that while a first experiment was successful all subsequent ones failed, and he feared therefore that yeast is too uncertain in its application to be of practical use. To this Professor Hagen replies as follows:—

"It seems evident that the yeast has not contained *Isaria* or other fungi obnoxious to insects to which the first success could be ascribed; otherwise the later application of the same fluid ought to have had the same effect, or even by the multiplication of the fungi a more marked effect.

"Experiments made in Germany and here (U.S.A.) had exactly the same result—first success, later failure. . . . After all, I believe it can be concluded that *a certain stage* of the yeast solution is needed to make it effective, and that after this stage it becomes indifferent. That yeast solution has killed insects seems to be undoubtedly proved, and it remains only to find out the stage in which its application is successful. It is sure that success, even in a very small number of experiments, cannot be annihilated by failure in other experiments."

Development of Fungi on the Outside and Inside of Hens' Eggs.‡—C. Dareste put an egg (for artificial incubation) in a vessel hermetically closed by an indiarubber stopper, and of small capacity (about 0·35 litre). On the sixth day the egg was covered with green spots of fructified mould; then there appeared on the

* See this Journal, iii. (1880) pp. 246–8.
† Canadian Entomologist, xiv. (1882) pp. 38–9.
‡ Comptes Rendus, xciv. (1882), pp. 46–9.

shell white filaments of mycelium, which in their turn soon showed fructification. When the egg was opened, some days afterwards, a tolerably thick layer of mycelium was found adhering to the shell-membrane. There was no trace of an embryo. Experiments with sixty eggs having the same origin gave only three entirely free from the cryptogamic vegetation. In several the embryo had begun to develope, and had been destroyed in the course of the first week. There were also in all the eggs considerable masses of mycelium, usually occupying certain points on the internal surface of the shell membrane, but, in certain cases also, floating in the albumen or ramifying in the yolk. When this mycelium was produced in the region of the air-chamber, the cavity was filled with fructifying green mould. The moulds were of several species (often co-existent), the most frequent being *Aspergillus*.

The author then considers the origin of these growths, and whether they ought to be attributed to the germination of spores adhering to the walls of the vessels used in incubation, or contained in the air inside them; to spores deposited on the shell during the interval between laying and incubation; or to spores enclosed in the egg itself before the completion of its formation in the oviduct?

Numerous experiments have led M. Dareste to doubt the two former explanations, he having heated the vessels which were to contain the eggs to 120° C. in order to kill any spores, and at other times used the spray of carbolated water; the vegetation nevertheless developed as abundantly as before. He therefore supposes that the spores were enclosed in the egg at the time when the yoke becomes covered in the oviduct with layers of albumen.

As, however, the methods used to destroy the spores are open to objection, he would not consider the latter to be the most probable hypothesis, did not other experiments point to it. The eggs used in the first experiments all came from the same locality (Seine-et-Oise). A batch of eggs from the department of Vienne, however, only had three infected eggs, and eight which were exempt. Eggs from the departments of the Oise and the Eure were experimented on at the same time as those from the Seine-et-Oise, and the latter, at the expiration of twelve days, had five eggs infected out of six. On the other hand, six eggs from the Eure had only two infected. The seven eggs from the Oise were, on the contrary, perfectly intact. This difference between eggs placed in absolutely identical conditions can only be explained by the inclosure of the spores in the eggs, in the oviduct, and before the formation of the shell. It shows also that the cause which infects the eggs is essentially local.

Gayon has demonstrated the mechanism of this infection. He has shown that the prolapsus of the oviduct, at the moment of copulation, places its mucous membrane in contact with that of the cloaca, and also with that of the cloaca of the cock. The oviduct, in resuming its original position, draws in with it the microbia and all the foreign bodies which it may find in these cavities. These circumstances are similarly produced at the moment of laying. The existence of foreign bodies in the interior of eggs has also often

been proved. M. Dareste recently observed that there were in the albumen of an egg some pellicles of bran perfectly recognizable by their structure, and by the considerable number of starch-grains which they contained; these pellicles were quite 1 mm. in diameter. The diameter of the spores can only be reckoned by thousandths of a millimetre.

In the experiments above described the eggs were in an atmosphere completely saturated with humidity in consequence of the insensible transpiration of the egg, but even in the ordinary conditions of incubation the spores enclosed within it may germinate, and the greater or less abundance of the vegetation may completely prevent the development of the embryo or arrest it after it has begun. This is one of the principal causes of the premature death of the embryo, and also of the inequalities constantly observed in the results of incubation.

Biology of Bacteria.*—During his researches on bacteria as reagents for the physiological disengagement of oxygen,† T. W. Engelmann had occasion to examine whether light could exercise a direct action on the movements of the bacteria. Nothing had at that time suggested such an influence. Experiments had been made on the ordinary bacteria of putrefaction (*B. termo*). The temperature, the tension of the oxygen, the proportion of carbonic acid, the concentration of the medium, the intensity, the colour and duration of action of the light had been modified in very different ways.

Later on, whilst repeating these same experiments on Vibrios and *Spirilla*, the author also obtained negative results, with one single exception.

A drop of water, which, besides a quantity of *Spirillum tenue*, only contained a few specimens of *Micrococcus* and a *Bacterium* of larger size (2–3 μ) being illuminated over a very small portion of its surface, there collected in less than half a minute,‡ at the illuminated spot, hundreds of *Spirilla* and, besides, some of the little cocci and larger bacteria. In the dark, and even in green or blue light, they re-distributed themselves, but not in the red light, even where it was of relatively feeble intensity. It may be presumed from this fact that there was a disengagement of oxygen, for when the gas failed them, the organisms in question accumulated round every source of oxygen (air-bubble, edge of the glass, cover-glass, and green cells) which was accessible to them.

The accumulation of *Spirilla* and bacteria at the illuminated spot did not take place when the drop of water was uncovered and in continuous contact with the atmospheric air or with a mixture of hydrogen and oxygen. They accumulated, however, as soon as a current of pure hydrogen was passed through the gas-chamber, to disappear again almost immediately as soon as a little oxygen was allowed to enter.

* Rev. Internat. Sci., ix. (1882) pp. 276–8. See also Bot. Ztg., xl. (1882) pp. 321–5, 337–41.
† See this Journal, i. (1881) p. 962.
‡ At least when the preparation had remained for some minutes covered with a thin glass.

As the *Spirilla* greatly predominated, as much in number as in volume, the author had at first considered it probable that it was they which disengaged oxygen under the influence of light. But *Spirilla*, even in thick layers, are quite colourless. We should, therefore, have here the unheard-of fact of a disengagement of oxygen without the agency of chlorophyll or of some pigmentary matter of equivalent function. This would demand extreme scepticism.

Later researches have shown that the *Spirilla* only approach the light when the drop also contains the larger bacteria mentioned above. The latter appeared constantly, although in very small numbers, at the illuminated spot, before the accumulation of the *Spirilla* began. On examining these bacteria with a high power and a good light, it was seen that they were of a greenish colour, but less intense, however, than that of most chlorophyll-grains of the same size. The author gives them the name of *Bacterium chlorinum*. They are not identical with *B. viride* and *Bacillus virens* of Van Tieghem, which are motionless forms. *Bacterium chlorinum* has, in a high degree, the tendency of accumulating in the light, but only when oxygen is absent. It is a property it shares with some other green micro-organisms, for instance, with *Paramecium bursaria*.

These results make it very probable that the accumulation of *Spirilla*, cocci, and bacteria, in the light, described at first, was the consequence of the disengagement of oxygen produced by the *Bacterium chlorinum* assembled in the illuminated spot. This explanation, however, only seems acceptable on the supposition that the *Spirilla* only required very little oxygen, much less than the ordinary bacteria of putrefaction, although they are much smaller.

To verify this supposition, the author has examined the behaviour of *Spirilla* under different tensions of oxygen. He found that in hydrogen gas as free as possible from oxygen, and even under a plate of glass with hermetically closed edges, they move rapidly many hours after the motion of the bacteria of putrefaction has ceased. Covered with a piece of glass, the *Spirilla* do not accumulate, like *Bacterium termo*, at the very edges of the cover, but at some distance under the glass. If the tension of the oxygen diminishes in the gas-chamber this distance decreases; if the tension increases the *Spirilla* retire further. Similar phenomena are observable under the glass cover, around air-bubbles, and green vegetable cells, living and exposed to the light. When the latter are strongly illuminated the zone of *Spirilla* ceases at a certain distance from them, parallel to their surface; it approaches when the luminous intensity diminishes, and *vice versâ*.

There is therefore no doubt that the tension of oxygen most favourable for *Spirilla* is not much lower than for *Bacterium termo*. It is certainly less than 150 mm. Hg., and may be considerably less. The *Spirilla* re-act at relatively very slight variations of the tension of oxygen. In these respects they behave like certain Flagellata (i. e. *Monas termo*) and Ciliata (*Glaucoma scintillans*), which develope by preference in putrefying liquids.

Vibrios—which, according to the author, cannot be strictly

separated morphologically from *Spirillum*, *Bacillus*, and *Bacterium*—also behave, as regards the tension of oxygen, almost exactly like *Spirillum* and not like *Bacterium termo*.

The author regards* *Spirillum* as remarkably sensitive to the presence of free oxygen; and he considers that the vital phenomena of both the lowest vegetable (Schizomycetes) and the lowest animal forms (Infusoria) are closely parallel to those of higher animals; their activity being dependent, in almost the same degree, on their requirements of oxygen and of solid and liquid food for carrying on their vital processes.

Influence of Concussion on the Developments of the Schizomycetes.†—J. Reinke has determined, by a careful series of experiments, that mechanical concussion produces a hindering effect on the production of Schizomycetes. He believes the cause to be the same as that of the retarding influence of light, viz. the concussion occasioned between the minute particles of protoplasm.

Experimental Production of the Bacteria of the Cattle-distemper.‡—C. v. Nägeli has carried out a series of experiments on the conditions under which the bacteria are produced which accompany the distemper of cattle. The most important fact established is that these bacteria are capable of transformation into a transitional form which may constitute a pellicle on the surface of the nutrient fluid, possessed of spontaneous motile properties, and which has a very slightly infectious character; constituting a transitional stage towards the hay-bacteria. The following is a tabular arrangement of the characters of the three primary forms, when grown in three different substrata. The author is strongly of opinion that these three fungi are simple adaptive forms of one and the same organism, *Bacterium subtile*.

	Distemper-bacteria.	Transitional Form.	Hay-bacteria.
1 p. cent. extract of meat.	Solution clear; cloudy at the bottom.	Solution cloudy, a loose mucilaginous pellicle; flakes and pieces of the pellicle at the bottom.	Solution clear, with a solid dry white pellicle, submersed with difficulty.
Slightly acid infusion of hay.	No increase.	Formation of a slight white rim on the surface of the fluid.	A dry pellicle moistened with difficulty, usually appearing wrinkled or pulverulent.
A living animal.	Infectious in very small quantities; distemper.	Infectious only when increased more than a thousand-fold; distemper.	Not infectious in the largest quantities.

* Pflüger's Arch. f. d. gesammte Phys., xxvi. (1881) pp. 537–45.
† Ibid., xxxiii. (1881) pp. 443–68. See Bot. Centralbl., viii. (1881) p. 307.
‡ SB. Akad. Wiss. München, 1882, pp. 147–69.

Bacteria of Caucasian Milk Ferment.*—E. Kern describes a new genus and species of bacteria found in "kephir," a drink prepared by the inhabitants of the high-lying lands in the Caucasus by fermentation of cows' milk. It is also used as a remedy against different diseases.

As a ferment in its preparation strange white lumps are employed, of a spherical or elliptical shape, in size from 1 m. to 5 cm. Microscopical examination showed that they consisted of yeast-cells and bacteria. The yeast-cells are the ordinary form, produced by cultivation, of *Saccharomyces cerevisiœ*, but Kern was unable to get these to the spore-bearing stage. The bacteria composed the chief part of the lumps, and were in the zooglœa state. The vegetative bacteria cells were 3·2 m. to 8 m. in length and 0·8 broad. In preparations put up by drying, a distinct cell-membrane could be distinguished.

Treated after Koch's method, the cells show at one end a locomotive organ, which resembles a cat-o'-nine-tails of threads. When exposed to acids or a high temperature, the cells grow out, probably through progressive cell-divisions, into long *Leptothrix* threads, which change generally precedes the spore-formation stage. The spores are round, always formed in twos in each cell, and are always placed standing on their ends; even by a Hartnack immersion X, no partition-wall could be discovered between the spores. In the *Leptothrix*-threads rows of spores could be observed, which are, however, always so situated that two spores belong to each cell. The spores while still in the cells are 0·8 μ in size; those lying free attain the size of 1 μ; the germinating spores swell up 1–6 μ. The germination of the spores generally takes place in such a manner, that an exosporium and an endosporium can always be distinguished in them. The thinner endosporium arises out of the thicker exosporium, first as a small excrescence, which gradually increases, developing more and more into a long cylindrical tube, and then begins by cell-division to form vegetative cells. The whole course of the development to the spore formation, beginning with the vegetative cell to the formation of a similar new cell, was followed.

This new form of bacteria, which undoubtedly belongs to the Desmobacteria of Cohn, is, in its vegetative state, not unlike *Bacillus subtilis;* it is, however, clearly distinguished not only from it, but also from all other kinds of Bacteria by its spore formation, since it always forms in each cell two round spores, placed end to end, while in the species of Bacteria hitherto described, only one spore has been noticed in each cell. On account of this sharply marked feature Kern places this form of Bacteria in a new genus, next to *Bacillus*, and calls it *Dispora caucasia* nov. gen. et sp.

A more exhaustive essay on the subject, with explanatory plates, Kern promises in a forthcoming number of the 'Bulletin de la Société Impériale des Naturalistes de Moscou.'

* Bot. Ztg., xl. (1882) pp. 264–6. Cf. Nature, xxvi. (1882) p. 43.

Parasitic Organisms of Dressings.*—The dressings of wounds sometimes acquire a blue or green colour. C. Gessard finds this to be due to a small mobile parasitic organism which he was able to cultivate in sterilized urine or a decoction of carrots. It is developed in saliva, sweat, albuminous liquids, &c. The blue pigment it secretes is the pyocyanine of Fordos. A current of sulphuretted hydrogen turns it green and then yellow, and the organism has the same action by reason of its avidity for oxygen.

Parasitic Nature of Cholera†.—Max v. Pettenkofer argues in favour of the origin of cholera from parasitic organisms. These organisms he believes to be propagated by intercourse with places in which the disease is epidemic or endemic; but that, when removed to another place, without losing their poisonous properties, they propagate themselves only when they find at this place a substratum which serves as their nutrient or as host, and which comes into contact with man either directly or in the soil of their dwellings. Even where cholera breaks out apparently without any connection with the soil, as in ships, he believes the germ comes into contact with the substratum brought from the land. The only effectual remedy for cholera he believes to be the purifying of the soil by drainage, &c., the ventilation of dwellings, cutting off of infected water, and similar means.

Parasitism of Tuberculosis.‡—H. Toussaint collected in a carefully cleansed vessel the blood from a cow affected with tuberculosis, allowed it to coagulate, and transferred the serum which separated after coagulation into some Pasteur's tubes filled with infusion of the flesh of cats, swine, and rabbits, and placed them in a warm chamber. After a few days there were formed in these fluids very small simple granules, united into pairs or in masses. From these was made a second culture with which kittens were infected, but they died before tuberculosis manifested itself. Five months afterwards he inoculated two older cats from the remaining serum, which still showed the globular granules. These died 47 days after inoculation; one exhibited a moderately conspicuous local lesion, and a considerably swollen axillary gland, but no tubercles in the lungs; the other, similar lesions, as well as of the lymphatic glands, and a number of minute tubercles scattered through both sides of the lungs. A second culture from the blood of a cow affected with tuberculosis must be regarded as having failed, since the greatest variety of microbia made their appearance. On the 1st of March he killed a pig which had been fed with the lungs of a tuberculose cow, containing a great number of tubercles, and in which all the lymphatic glands were cheesy. Blood and the pulp from the lymphatic glands were mixed with a slightly alkaline infusion of

* Comptes Rendus, xciv. (1882) pp. 536–8.

† Zur Aetiologie der Infectionskrankheiten, 1881, pp. 333–52. See Bot. Centralbl., ix. (1882) p. 25.

‡ Comptes Rendus, xciii. (1881) pp. 350–3.

the flesh of rabbits, which they soon rendered turbid, all developing the same microbium. The cultures, which were continued up to the tenth, completely retained their purity. After ten or twelve days they always ceased to increase, the exhausted fluid became clear, and the microbia fell to the bottom, forming a yellowish sediment. This sediment consisted entirely of extremely minute granules, which were produced singly or in pairs, groups of from three to ten, or in small irregular masses. During the early days of the culture white spots appeared, resembling the filaments of bacteria, which could be sucked up through a fine tube. They remained for some days in the clear fluid without becoming absorbed, the microbium being at this time enclosed in a somewhat firm mass of mucilage.

Experimental Tuberculosis.*—D. Brunet records experiments on inoculation with tuberculosis made in 1869 on rabbits. Nineteen young rabbits were infected, seven with serum from a cancer, six with serum from an ordinary ulcer, and six with tuberculose matter. Of the nineteen, fourteen became tuberculose, the remaining five escaped. Since infection with cancer-serum produced tuberculosis as often as infection with tuberculose matter, he thought it probable that the infecting mass itself produced no specific action, but that it behaved as a foreign body, causing inflammation around it, and that this gave rise to tuberculosis. Since the matter from ordinary ulcers was more easily absorbed than solid matter, it produced a smaller degree of inflammation, and hence gave rise less often to tuberculosis.

Etiology of Tubercular Disease.†—The circumstantial evidence that tuberculosis is a chronic infectious disease has been of late years repeatedly insisted on by Cohnheim and others, and the hypothesis that it is due to a specific organism has received considerable support from the discovery of parasitic elements as the *materies morbi* of some other chronic infectious diseases, such as leprosy. But the organism of tubercle has hitherto eluded research. Its discovery is at last announced by the distinguished worker to whose investigations much of the progress of bacterial pathology has been due, Dr. R. Koch.

It is only by means of a special method of preparation and examination that the bacteria can be detected. The method consists essentially in a process of colouring the organisms, and their examination under very strong illumination; but the details of the method have to be varied according to the tissue examined, whether a secretion, blood-tissue fluid, or a section of an organ or tissue. If, for instance, it is desired to demonstrate the presence of the tubercle-bacilli in the fluid of the tissues, a thin layer of this is spread over a cover-glass, it is then dried and warmed for a few moments over a flame, so as to

* Comptes Rendus, xciii. (1881) pp. 447–8.

† Verh. Physiol. Gesell. Berlin, 1882, p. 65. Lancet, 1882, pp. 655–6. Naturforscher, xv. (1882) pp. 149–50.

render it insoluble; it is then placed for twenty-four hours in a mixture of 1 cubic centimetre of a concentrated solution of methylene-blue in alcohol, 0·2 cubic centimetres of a 10 per cent. solution of potash, and 200 cubic centimetres of distilled water. The preparation is by this coloured blue, and on it is then placed a few drops of a solution of vesuvin. This has the effect of discharging the methylene-blue from all the tissue elements, but not from the bacilli. The former are of a brown colour, and the blue bacilli are conspicuously defined. The preparation is then treated with absolute alcohol, oil of cloves, and Canada balsam, in the ordinary manner. This peculiarity of being rendered visible by the combined action of methylene blue and vesuvin is possessed only by the tubercle bacilli and by those of leprosy. All other bacteria and micrococci, known to Koch, lose, under the action of vesuvin, the blue colour which they acquire from methylene-blue. This constitutes a striking instance of the pregnant value of the colouring methods in thus, by quasi-chemical action, bringing out differences between minute organisms which are apparently so similar, and justifies the expectation that, by analogous means, differences may be demonstrated between the organisms of acute diseases which are now separable with so much difficulty and uncertainty, and may be the inauguration of a new era, not only in the etiological knowledge of acute diseases, but also in the organization of measures for their prevention.

The bacilli of tubercle, when rendered visible by this method of double coloration, are seen as very small rods, in length about one-third the diameter of a red blood-corpuscle, and in breadth about one-sixth of their length. In some of them distinct spores may be seen, as minute, unstained, refracting, vacuole-like structures, distinguishable, however, from the vacuoles in that at their position there is a slight fusiform enlargement of the bacillus. They are most abundant in recent tubercular neoplasms, and least numerous in the caseating centre of old miliary tubercles. They are also visible within the giant cells, usually isolated, but sometimes forming well-marked sheaf-like bundles. Koch found the same organisms in the walls of tuberculous cavities, in the sputum of phthisical patients, in degenerated scrofulous glands, in fungous joints, and in the bones of tuberculous cattle. They were never absent from the tubercular new formations produced by inoculation, even in animals of the most different species.

In order to ascertain the all-important question whether these organisms are actually the *materies morbi* of tuberculosis, Koch has carried on an extensive series of culture-experiments, which have yielded the most striking results. As a culture-liquid he employed sterilized blood-serum from the ox. The sterilization was effected in the method recommended by Tyndall, by placing the serum in a test-tube closed with a plug of wadding, and exposing it for an hour on each of several successive days to a temperature of 58° C. After this had been repeated for about six days, the temperature was raised to 65° C., and the previously fluid serum became transformed into a yel-

lowish, translucent, but slightly opalescent mass of the consistence of coagulated gelatine. Its translucency permitted the growth of organisms, either on its surface or in its depth, to be readily recognized by the resulting opacity. In order to increase the area of the free surface of this culture soil, it is recommended to incline the test-tube at the moment of coagulation. A small fragment of excised tissue was introduced into a tube under special precautions, to avoid contamination with ordinary bacteria of putrefaction. Fresh miliary tubercle answers best, taken from an animal affected with inoculation-tubercle, and killed shortly before. If the glass is kept at a temperature of 37° or 38° C., at the end of about ten days the first effect of culture is observable as fine white points and streaks on the surface of the serum. Fresh glasses may be inoculated from this first culture, and so a series of generations may be obtained. Some of these series of cultures were continued for two hundred days. Under the microscope these greyish-white masses on the surface of the serum are found to consist of precisely the same bacilli as can be demonstrated by means of the method of double coloration, in the primary tuberculous tissue. If a small portion is inserted into the anterior chamber of the eye of an animal, injected into its blood, or inoculated beneath its skin, there results a wide-spread tuberculosis of almost all the organs and tissues, which has a more rapid course than when the inoculation is made with ordinary tuberculous material. The first symptoms are to be observed in guinea-pigs ten days after the inoculation. Even animals which enjoy an almost complete immunity from tuberculosis, such as dogs and rats, are affected rapidly, and with certainty. In some of the animals which died after these inoculations, the amount of tubercle developed in the tissues was enormous, being hardly ever equalled in the human subject.

Koch determines the limits of temperature between which the tubercle-bacillus can develope and multiply. The *minimum* temperature he finds to be 30° C., and the *maximum* 41° C. He concludes that, unlike the *Bacillus anthracis* of splenic fever, which can flourish freely outside the animal body, in the temperate zone animal warmth is necessary for its propagation. He also points to the grave danger of inhaling air in which particles of the dried sputa of consumptive patients mingles with dust of other kinds.

These experiments seem to demonstrate that the organism which is revealed by the method of double coloration is really the pathogenic element of tuberculosis. The researches appear to have been conducted with admirable care. The experiment will no doubt be soon repeated. Indeed, in the brief interval which has elapsed since the demonstration by Koch, on March 24th, his observations have received independent confirmation by Baumgarten, who has published in the Centralblatt für Med. Wiss. an account of his observations. In every new formation of artificially produced tuberculosis in the guinea-pig he found innumerable quantities of the rod-shaped bacteria infiltrating the area in diminishing intensity from the centre to the circumference. As far as the tubercular growth can be traced the

bacterial infiltration extends. His description of the organisms agrees closely with that of Koch, but he observed that the extremities of the rods frequently presented a knob-shaped or wedge-shaped enlargement. They were very rarely united in pairs, and never massed in the so-called zooglœa form. He corroborates their characteristic of resistance to the ordinary methods of tinting, and only succeeded in bringing them into distinct view by dilute alkalies. In a postscript Baumgarten adds that he has succeeded in finding the same organisms in human tubercle. The pathological importance of the discovery of the proximate cause of this frightful scourge of the human race cannot be over-estimated, nor is it possible to foretell the practical results to which it may lead.

Lichenes.

Structure and Development of the Apothecia of Lichens.*— The well-known structure of the apothecium of lichens described by Stahl is taken from the Collemaceæ, where it is a product of an act of impregnation performed by the spermatia. The female organ or carpogonium here consists of two parts, a lower coiled portion, the ascogonium, and an upper multicellular filament, the trichogyne, through which impregnation by the spermatia takes place. After this process the trichogyne dies, and a fibrous tissue springs from the ascogonium, composed of the asco-filaments which later develope into the asci; these are therefore the product of the fertilized ascogonium, with which the paraphyses have no direct connection.

Since the Ascomycetes vary greatly in the mode of development of their fructification, it is to be expected that a similar variation should exist in the development of the ascogonium of lichens, especially in those genera which do not possess a spermogonium. G. Krabbe has investigated this subject in detail, with special reference to the genus *Sphyridium*; and the following are the main results at which he has arrived. The author throughout uses as synonymous the terms apothecium, fruit, fructification, and reproductive shoot.

1. The genus *Sphyridium* exhibits a differentiation between the apothecium resulting from an entire scale of the thallus or from a part of one. The asco-filaments are the apices of ordinary hyphæ, the cycle of development of *S. carneum* terminating with their production. The production of the ascogonium is most probably independent of any act of impregnation.

2. In *Cladonia* two morphologically different structures exercise the function of fructification in different species, viz. *a*, a pseudopodetium or modification of the thallus; *b*, a podetium or new shoot complete in itself (carpophore). Both podetia and apothecia are of ascogenous origin. *C. bacillaris* and *Papillaria* are diœcious. The following are the most important points regarding the power of producing shoots possessed by the apothecium.

3. The apothecium of lichens possesses the property of putting out apothecial shoots at any spot, viz. *a*, from the hymenium, in *Cladonia Papillaria* and *Lecidea Pilati*; *b*, from the periphery of the paraphysal

* Bot. Ztg., xl. (1882) pp. 65–83, 85–99, 105–16, 121–42 (2 pls.).

tissue, or excipulum proper, in *Pertusaria; c*, from the hypothecium, in *Phlyctis*.

4. From this power of producing shoots must be distinguished the division of the apothecium, by which, in *Pertusaria*, the isolated portions of the apothecium are produced, and in *Gyrophora* those chambers, each of which, separated from the others by a circular wall, must also be regarded as a thallus-apothecium.

5. In *Pertusaria* no paraphyses are formed; the asci are developed directly in the original tissue.

6. In *Phlyctis agelæa* the paraphyses begin to shoot while the asci are dying off, and thus again take part in the formation of the thallus.

7. The apothecium of *Phialopsis*, at first entirely angiocarpous, is subsequently rendered gymnocarpous by secondary processes.

Structure of Crustaceous Lichens.*—J. Steiner has carefully studied the structure of the thallus of crustaceous lichens, especially in the cases of *Verrucaria calciseda* and *Petractis exanthematica*. He finds two ways in which the gonidia are formed. The first is an endogenous mode, by division of the entire protoplasm of the hyphal cells, after it has surrounded itself with a new membrane. The other is a kind of free-cell-formation, several daughter-cells being formed simultaneously in the protoplasm of the mother-cell. The author also finds that micro-gonidia (of Minks) are formed in the mother-cell by free-cell-formation. He uses chromic acid largely in his preparations.

Cœnogonium and the Schwendenerian Theory.†—The genus *Cœnogonium*, established in 1820 by Ehrenberg, comprises about twenty species which grow in the warm regions of the two hemispheres. The filamatous elements of the thallus present a great resemblance to the filaments of *Conferva*, and Dr. Karsten and Professor Schwendener recognized in 1862 that around some large confervoid filaments there exist other filaments much more slender, having a diameter of about 1–2 μ, which appear to be hyaline, and which creep in some measure on the surface of the large green filaments. There is but one single series around the green filaments, and yet this series is interrupted, the slender filaments not touching laterally in a regular manner, but often showing some anastomosis, and there occasionally form, at least in places, a rather close network. Hence there are two constituent elements in the thallus of *Cœnogonium* as in other Lichens, the large green cells still enclosed in their mother-cells, corresponding to the gonidia, and the slender hyaline filaments corresponding to the hyphal filaments.

It is clear, then, writes Dr. J. Müller, "that according to the celebrated theory of Professor Schwendener, announced in 1867, the large green filaments will represent the nourishing alga, and the

* Programme k. k. Staats-Obergymnasiums, Klagenfurt, xxxi. (1881) (2 pls.). See Bot. Centralbl., viii. (1881) p. 228.

† Arch. Sci. Phys. et Nat., 1881, p. 370. Ann. and Mag. Nat. Hist., viii. (1881) pp. 427–9. Grevillea, x. (1882) pp. 87–9.

slender hyphal filaments will be the parasitic fungus, the two forming together the thallus of a plant which should no longer, because of this union, have its legitimate place amongst the series of the classes of plants."

In examining a new species, *C. pannosum*, from Brazil, Dr. Müller claims to have discovered "a remarkably demonstrative case," which confirms the general results recently published by Dr. Minks.

One of the filaments in a great part of its length measured 8 μ in diameter, and was composed only of a large green tube similar to the large green tube of other filaments of the same stratum, and contained the cylindrical green gonidia which simulated some articulations of *Conferva* and is the alga of the theory. But at a certain point this tube suddenly narrowed and became a very slender capillary tube only 2 μ in diameter, without there being any discontinuation of the cavity, the whole forming one single cell, at first large and afterwards very narrow, perfectly similar to the slender hyphal tubes of the theoretic fungus which enclose the large green tubes or theoretic alga in other filaments of the same species. The capillary part, moreover, showed clearly the microgonidia in their natural form, size, and arrangement. "It follows that one and the same cell would have been the theoretical alga on the enlarged gonidia-bearing side and the theoretical fungus on the other side which remained narrow and contained microgonidia, thus proving in the most absolute manner the falsity of the theory, as the same cell cannot at the same time belong to two classes of plants. There is neither fungus nor alga; the whole is lichen, nothing but lichen; and the two kinds of tubes, so different at the first glance, are only different states of evolution of one individual organ. The very slender hyphal tubes are the first part containing the microgonidia. This first part may remain always in this state, or it may also enlarge and lengthen, while the microgonidia, originating by free-cell-formation, may pass into the stage of gonidia, and then the narrow hyphal tubes will become large gonidia-bearing tubes."

Algæ.

Crystalloids of Marine Algæ.* — J. Klein states that the crystalloids found in marine algæ are of two kinds:—(1) Colourless or less often brown crystalloids, occurring in the living cells as a constituent of their cell-contents, and differing in no essential respect from the crystalloids of other plants; and (2) crystalloids of a carmine-red colour formed only by the action of certain reagents, as sodium chloride, alcohol, or glycerin, on the cell-contents of the Florideæ, or occasionally formed outside the cells—the rhodospermin of Cramer.

Of the first kind Klein describes the crystalloids found in 20 species of marine Algæ, 5 of them green, the other 15 belonging to the Florideæ; they differ greatly in form and size, two or three modifications sometimes occurring in the same species. They are found within the parietal protoplasm, floating in the living cell, in the

* Pringsheim's Jahrb. f. wiss. Bot., xiii. (1881), pp. 23–59 (1 pl.). Cf. this Journal, iii. (1880) p. 494.

cell-sap. They are all coloured brown by alcoholic solution of iodine, and show the other ordinary reactions of proteinaceous crystalloids. They occur most abundantly either in very large-celled Algæ like *Cladophora* and *Griffithsea*, or in those the vegetative thallus of which is unicellular, as *Acetabularia*, *Bryopsis*, *Codium*, and *Dasycladus*; their size and number being apparently dependent on the size of the cells in which they occur. They appear to result from the development in the cells of an excess of proteinaceous substances. In some instances, as *Acetabularia*, where they are found only in specimens in which there are no spores, they are used up in the formation of the spores.

Rhodospermin has been observed by Cramer and Cohn in *Bornetia secundiflora*, *Callithamnion caudatum*, *C. seminudum*, and *Ceramium rubrum*, in which Algæ it is formed by the long-continued action of the reagents named. What appear to be immature crystalloids of rhodospermin have also been detected by Klein in specimens similarly treated of *Griffithsea phyllamphora* and *Phlebothamnion versicolor*.

Phyllosiphon Arisari.*—This organism, parasitic on the leaves of *Arisarum vulgare* in Italy, was first observed and described by J. Kühn, who regarded it as a Siphonaceous Alga allied to *Vaucheria*. Schmitz has also investigated it, chiefly in reference to its multi-nucleated cells, and considers it to be a fungus constituting a special group of the Phycomycetes. L. Just has now undertaken a complete investigation of its structure and life-history.

The parasite causes well-defined light-green or yellowish patches on the leaves and leaf-stalks of the host, each patch being inhabited by a single individual, which attacks the intercellular spaces only. Each individual consists of a single entirely undivided but often much-branched interwoven hypha, averaging about 0·05 mm. in diameter.

The young apices of the branches contain no chlorophyll, but a colourless protoplasm rich in larger or smaller granules (microsomes) and containing vacuoles and drops of oil. Further from the apices of the branches, the hypha is gradually more and more deeply coloured by chlorophyll, and contains a larger quantity of oil. When the spores are about to be formed, a parietal layer of protoplasm becomes nearly homogeneous, and comparatively free from oil-drops, while a layer of protoplasm next to this gradually breaks up into numerous minute portions, which clothe themselves with cellulose-coats, and develope into the spores. The innermost central portion of the protoplasm is rich in oil, but contains comparatively few granules and no chlorophyll; it absorbs water greedily and swells up. The escape of the spores takes place from ten to fourteen days after the first appearance of the patches. Just confirms Schmitz's statement of the occurrence of a large number of nuclei in the hyphæ; but he did not, like Schmitz, at a subsequent stage find one in each spore; the spores are entirely destitute of nucleus.

The spores are of oval form, averaging about 5 μ in length and 2·5 μ

* Bot. Ztg., xl. (1882) pp. 1–8, 17–26, 33–47, 49–57 (1 pl.).

in diameter; and at the time when they are formed the hyphæ are found to contain large quantities of starch, which is partly used up in the formation of their cellulose-wall, and which is no doubt derived from the oil that is present at an earlier stage ; the spores themselves do not contain starch. Portions of the hyphæ remain colourless, and in these no spores are formed.

Although *Phyllosiphon* is found only in the intercellular spaces of the leaf and leaf-stalk of the host, the protoplasmic contents of the neighbouring parenchymatous cells undoubtedly supply it with nutriment, and it must be regarded as a true parasite. The intercellular spaces become in time entirely occupied by it, so that the respiration of the host must be greatly impeded.

As soon as the spores are completely formed in a portion of a branch, they escape spontaneously, the expulsion being caused by the great capacity for swelling possessed by the central portion of the protoplasm, the parietal layer at the same time contracting, and being ruptured in consequence. There is always, however, a certain proportion of the spores left behind in the hypha, surrounded by a portion of the protoplasm, and connected with one another by fine bands of protoplasm. The portions of the hypha which burst are frequently immediately beneath stomata, through which the spores are forced. This takes place chiefly on the under side of the leaf, the hyphæ forcing themselves only rarely and with difficulty between the comparatively closely packed palisade-cells which lie beneath the epidermis of the upper surface. The expulsion is effected with great energy, the spores being forced on to the external surface of the leaf. Those which remain in the hyphæ continue to grow, some of them attaining the size of 8 μ diameter and more ; while others remain about the size of the expelled spores.

That the green colouring-matter of *Phyllosiphon*, although not occurring in the form of distinct grains, is chlorophyll, is beyond doubt; an alcoholic solution shows all the characteristic spectroscopic properties of this substance. It appears certain that this chlorophyll is not derived directly from that in the leaf-cells of the host; but that it is formed by the organism itself. Its purpose appears to be not to decompose carbonic acid in the hyphæ, but to pass entirely into the spores, which carry on an independent development outside the host, and require the chlorophyll for this purpose.

All attempts at artificial germination of the spores failed, both of those that are expelled, and of those, whether larger or smaller, that remain in the hyphæ ; as also did similar experiments with the hyphæ themselves. The reason of this failure is no doubt that the spores require to go through a period of rest before germinating. In nature this period of rest extends from the middle of March, when the patches are most abundant (no fresh ones being formed after the middle of April) till December, when they begin to appear again.

Until the complete life-history of *Phyllosiphon* has been followed out, its systematic position must remain in uncertainty. Schmitz's view, that it belongs to the Phycomycetes, must be entirely abandoned ; nor does the mode of formation of the spores justify us in placing it,

with Kühn, among the Siphonaceæ. Its parasitic character is the only point which gives countenance to the idea that it presents a transitional form between Algæ and Fungi. All that can be certainly stated of this organism is that it is an alga which inhabits the leaves and leaf-cells of *Arisarum vulgare;* and that its spores pass through a resting stage outside the host.

Structure of Corallina.*—Count Solms-Laubach has carried on a series of observations, in the zoological station at Naples, on the structure of *Corallina* and its allies. The strong calcification of the cell-walls, and the scarcity of the sexual plants, present great difficulties in the way of their examination.

There is no difference in the origin of the tetrasporangia and of the conceptacles of the sexual organs in *Corallina.* The apex of a shoot first of all becomes depressed, and then hollowed out with a more or less narrow opening. At the bottom of this cavity are found, in the tetrasporangia, elongated cells, the transverse division of which produces the tetraspores with intermediate paraphyses. The conceptacles which produce the spermatia bear a close resemblance to the spermogonia of fungi. The filaments which bear the spermatia project from the opening; at their extremities are from two to four minute cells, each of which bears a tuft of very fine sterigma-like threads; and from these sterigmata the spermatia are separated by abstriction. When free the spermatium appears as if tailed, from a piece of the sterigma still remaining attached to it.

The procarps are formed from the cells which make up the floor of the conceptacle. Their development advances from the centre towards the margin; but while the central trichogyne becomes in the meantime prepared for impregnation by a club-like swelling at its apex, they become smaller and less frequent towards the margin, and the outermost procarps of all have no trichogynes in a receptive condition. Notwithstanding this, the production of spores commences with the marginal procarps. While in the majority of the Florideæ each procarp produces a cystocarp, in *Corallina* only one is formed in each conceptacle, resulting from the development of all the procarps. After impregnation all the carpogenous cells of the procarp coalesce laterally by resorption of the separating walls. The "carpogenous fusion-cell" thus formed developes the spores from its entire margin; in *C. mediterranea* club-shaped cells are produced in great numbers from the indented edge, are separated by a wall from the fusion-cell, and produce the spores by transverse division. This process exhibits a hitherto unknown variety in the mode of producing fruit, resembling in some respects that in *Dudresnaya.*

The author draws a comparison between the "sister-procarps" of *Dudresnaya*, and the oosphere and synergidæ or "sister-archegonia" of Angiosperms.

The treatise concludes with a description of the allied genera *Amphiroa*, *Melobesia*, *Lithophyllum*, and *Lithothamnion*, especially as

* Graf zu Solms-Laubach, 'Corallina: eine Monographie,' 1881 (3 pls.). See Bot. Ztg., xxxix. (1881) p. 795.

regards the mode of formation of the fruit. A new species, *Melobesia deformans*, is described as parasitic on *Corallina natalensis*, in which, instead of the usual regular pinnate structure of the apex of the thallus, it branches in all directions into short irregular branches. *M. callithamnioides* produces peculiar gemmæ, reminding one of those of the Sphacelarieæ.

Impurities of Drinking Water caused by Vegetable Growth.*— W. G. Farlow gives a résumé of what is known respecting the vegetable substances which cause impurities in drinking water. The most injurious are the blue-green algæ the Phycochromaceæ, but only after death. They do not, however, produce infectious diseases; *Beggiatoa* gives off sulphuretted hydrogen. The following are described in detail:— *Cœlosphærium Kutzingianum*, *Clathrocystis æruginosa*, *Anabæna flos-aquæ*, and *Lyngbya Wollei*.

Fossil Siphoneæ.†—Meunier-Chalmas has determined the eocene genus *Ovulites* to be identical with *Penicillus* Link., *Nesea* Lmx., and *Coralliodendron* Ktzg., from which he establishes a new section of Siphoneæ, distinguished by their dichotomous branching. One of the eocene species is closely allied to the existing Mediterranean *Coralliodendron mediterraneum*. These were previously regarded as constituting a class of Protozoa, under the name Dactyloporideæ, to which also belongs *Triploporella*, found by Steinmann in the calcareous beds of the Lebanon.

Falkenberg's Algæ.‡—In his new 'Handbook of Algæ,' Falkenberg follows in the main de Bary's classification §; but introduces the doubtful innovation of calling one of his four classes (including Melanophyceæ and Chlorophyceæ) Algæ in a restricted sense. The author uses the term "gametes" for any masses of protoplasm, in both Thallophytes and Archegoniatæ, union of which constitutes a reproductive act, including therefore oospheres and antherozoids; the result of this union, whether hitherto known as zygospore, oospore, or fertilized ovum, he calls a "zygote." In the Florideæ we have a distinct mode of fertilization, viz. the impregnation of a multicellular female organ, the "procarp," which developes into the fructification containing the carpospores. The larger and smaller groups are described with great clearness and an admirable selection of the salient characters; there is copious reference to the literature of each section; and the illustrations, though not very numerous, are excellent, many of them being new. Unfortunately there is nothing in the shape of an index.

Motion of Diatoms.||—Mr. C. M. Vorce, while being unsatisfied with any of the theories advanced and having none of his own,

* Suppl. to First Ann. Rep. of Massachusetts Board of Health, 1880, pp. 131–52 (2 pls.).

† Bull. Soc. Geol. France, vii. (1881) pp. 661–70. See Bot. Centralbl., viii. (1881) p. 270.

‡ Falkenberg, P., 'Die Algen in weitesten Sinne,' Breslau, 1881 (Encyklopädie der Naturwissenschaften, 1te Abtheil., 23 Lieferung).

§ See this Journal, i. (1881) p. 273.

|| Amer. Mon. Micr. Journ., iii. (1882) pp. 43-5.

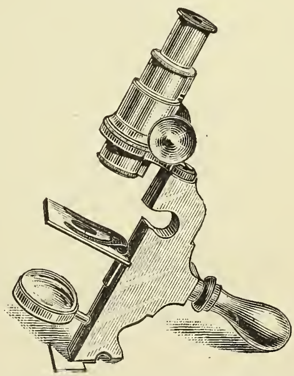
records some of the results of his observations. Many of the phenomena connected with the motion of diatoms, indicate that the frustules are enveloped in a membrane which, if adhesive, would cause many of the appearances noted, provided the motion be accounted for. Where extraneous matter is seen trailing after a diatom it is, however, as likely that the adhesive property resides in it as in the diatom. The remarkable alternation of motion seems a very strong objection to the ciliary theory and equally so to that of prehensile filaments. No other ciliated or flagellate organism exhibits such alternations. Not even in the case of large diatoms when moving with great force can any trace of cilia or filaments be seen. If ciliary action or currents produced by osmose were the true explanation, we should expect them to move adjacent particles when the diatom is held fast, but yet free particles are not moved nor is there any evidence of current in the water, except where it is in contact with the diatom. In fact, none of the suggested causes of motion explain satisfactorily all the phenomena observed, and the problem still lies open to some persevering observer.

MICROSCOPY.

a. Instruments, Accessories, &c.

Griffith's Portable Microscope.*—Mr. E. H. Griffith has further modified this instrument, which now "has the usual coarse adjustment by rack and pinion, which is very accurately made, and by an ingenious addition, serves also as a fine adjustment. A ring is mounted on the axle of the hand-wheel; a set-screw clamps the hand-wheel when the coarse adjustment is effected, so that it cannot be moved, and all danger of breaking the slide is avoided. Then a lever working in the ring moves the tubes by means of the same rack and pinion. As the lever is itself moved by a worm-screw, it forms a very exact and delicate focussing arrangement."

Fig. 61.



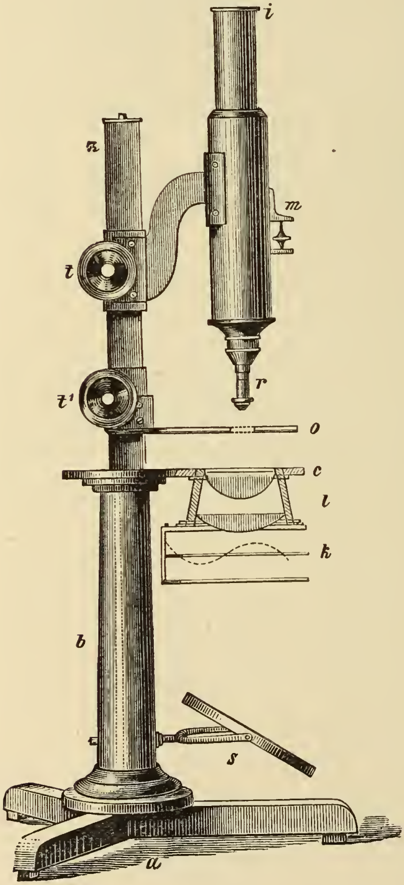
Parkes' Class Microscope.—Messrs. Parkes have adapted the Microscope described *ante*, vol. i. (1881) p. 655, for use as a Class or Demonstrating Microscope. It is shown in Fig. 61. The handle, in conjunction with the base of the stand, enables it to be placed on a table in the ordinary way when so desired. The condensing lens more usually employed when the instrument is being handed round a class can be replaced by a mirror.

Pringsheim's Photo-chemical Microscope.—Professor Pringsheim's researches on the functions of chlorophyll in the life of the

* Proc. Amer. Soc. Micr., 1881, p. 85.

plant, and the connection of its production and destruction with the intensity of the light, have been already fully described,* and we now add Dr. A. Tschirch's description † of the special Microscope which Professor Pringsheim constructed for observing the effect of a high intensity of light on objects directly on the stage, and to carry out his method of "microscopical photo-chemistry"— a method which he considered would also be valuable in investigating the action of light on protoplasm and the formed constituents of the cell-body, for investigations on the sensations of heat in the lowest animals, and in certain cases for ascertaining the truth respecting the presence and seat of the perception of light.

Fig. 62.



The instrument is three times larger than the ordinary [German] Microscopes, and its form resembles that of the older Schieck stand. Upon a firm tripod *a* rests the conical column *b*, to which is fixed the large round mirror *s*. The latter is 160 mm. in diameter, and is as strictly plane as possible. It receives the sunlight from a heliostat, whose mirror must be considerably larger than that generally used, so that the mirror of the Microscope may be fully illuminated at any altitude of the sun; 235 mm. by 165 mm. is a sufficient size. At a distance of 165 mm. above the mirror, the column supports a large stage *c*, about 110 mm. square, beneath which the lens-system is screwed for the production of the sun's image. In the instruments hitherto employed, a doublet of two plano-convex lenses is made use of, placed in the same frame *l*, 28 mm. from each other. The lower has an aperture of 66 mm. and a focus of 93 mm., the aperture of the upper being 48·4 mm. and the focus 35 mm. In this position they form a round image of the sun 0·35 mm.

* See this Journal, iii. (1880) pp. 117–19, 323–4.
† Zeitschr. f. Instrumentenk., i. (1881) pp. 330–3 (4 figs.).

in diameter, and although the lenses are not perfectly achromatic, yet it is not too strongly coloured at the margin by chromatic aberration.

Below the doublet another piece of apparatus can be screwed with either two springs, or better a double fork *k*, for holding the coloured solutions or glasses for producing monochromatic images, also the media for the absorption of the dark heat-rays. If it be required to have additional vessels for the absorption of heat or to employ different absorption media at the same time, others can easily be fastened under the forks by indiarubber rings, the height of the stage *c* above the mirror giving sufficient space for four or five. It is not advisable to fix them above the lenses upon the stage *c*, because while the warmth beneath the lenses extends uniformly through the whole of the fluid, there is above them a very hot cone of rays, which strongly heats a small portion of the absorption liquid, and with liquids such as iodine in bisulphide of carbon explosions may easily take place. Indeed, it is in this case necessary, instead of the Desaga bottles (at first exclusively employed by Professor Pringsheim), to use glass boxes for holding the absorption fluids, of greater width than the aperture of the doublet. For this purpose round, well-polished glass rings can be employed, 10 mm. deep, closed on either side by flat glass plates, held together by strong indiarubber rings. If these are carefully closed, all aqueous solutions can be kept in them for months without evaporating to any considerable extent, particularly as a stratum of small crystals speedily forms at the edge, and thus makes them still more air-tight. Solutions of bisulphide of carbon must often be renewed, because they evaporate, even when most tightly closed.

After many experiments, the following have been proved to be the best absorption fluids:—For the absorption of red-yellow, a solution of ammonio-oxide of copper; for the blue and red ends of the spectrum, solutions of chloride of copper, obtained by the evaporation of a saturated solution of the salt, according to the intensity of the colour and the extent of the absorption; for the green-violet, a solution of bichromate of potassium ($K_2Cr_2O_7$); and for the orange-violet a solution of iodine in bisulphide of carbon or iodine in iodide of potassium. As far as can be at present ascertained, solutions of organic pigments or of aniline colours are unsuitable, at least they possess no superiority over the above solutions. Coloured glass plates may be used, if perfectly uniform. Of course, the value of all media for absorption must first be tested in the spectroscope. Water or a concentrated solution of alum can be used for the absorption of the dark heat-rays.

Above the fixed lower stage is the movable stage *o*, moved by the screw t^1. It is pierced in the centre, and serves to carry the slide, the gas chambers, &c. By means of the screw, the object can be brought into the plane of the sun image formed by the lenses, or immersed in it if necessary. The screw t^1, as well as *t*, which moves the microscope-tube, works on a triangular bar *z*. The screw *t* gives the coarse focussing, after the object on the stage has been adjusted by means of t^1, whilst the micrometer-screw *m* gives the necessary fine focussing

movement. The objective is shown at *r*. (The author says that it is better to produce the fine adjustment by means of a screw on the end of the tube, similar to the correction adjustment of objectives.)

To be able to produce a clear image of the sun, the whole of it must be seen, and therefore only low powers can be used. The field must be about 1 mm. in diameter. To protect the eye against the intensity of the light, a number of smoked glasses can be placed on the eye-piece *i*.

Two methods were employed by Professor Pringsheim for the temperature determinations *: (*a*) the insertion of a thermo-electric couple of iron and nickel into the drop, the results being read off by a galvanometer; and (*b*) the introduction of small crystals of substances of known melting-point. For the latter purpose two substances, azoxybenzol, which melts at 45° C., and mint-camphor, with its melting-point 35° C., were found most convenient.

Waechter's (or Engell's) Class or Demonstrating Microscope.—This instrument might readily be mistaken for an ordinary brass candlestick. Its original form is figured by Harting †; Figs. 63 and 64 show it as improved by Waechter, the lower part being seen in Fig. 63 *in section*.

Fig. 63.

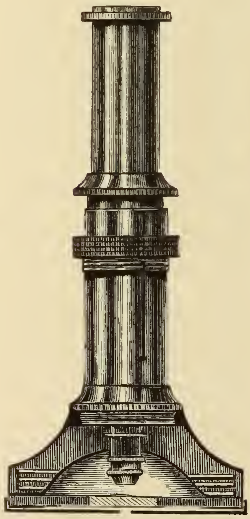
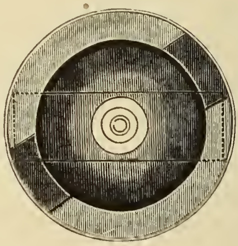


Fig. 64.



The body-tube, carrying eye-piece and objective, slides in an outer "sprung" tube which is attached at its lower end to a conical base, which forms a wide support for the instrument to stand upon when not in actual use. The inside of the base is polished so as to reflect light upon opaque objects. The ends of the slides are held beneath a metal ring at the lower end of the base, as shown in Fig. 64, and they can be removed by turning them round till they coincide with the two openings in the ring. The instrument is held up to the light and focussed by sliding the inner tube in the usual way. It can be secured at any given focus if desired by the milled clamp ring near the top of the sprung tube. A cover fits over the base (shown in Fig. 63) and is pierced with a small hole to act as a diaphragm with high powers.

The instrument is intended for class demonstration.

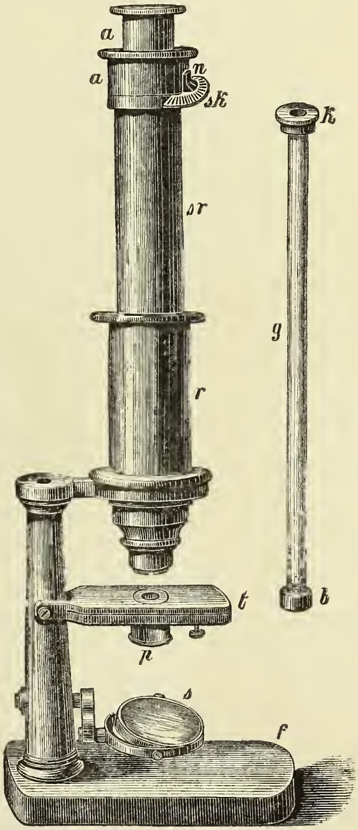
* See translation of Prof. Pringsheim's Researches by Prof. Bayley Balfour, Quart. Journ. Micr. Sci., xxii. (1882) pp. 76–112 (2 pls.).

† Harting, P., 'Das Mikroskop,' iii. (1866) pp. 196–7 (2 figs.).

Wasserlein's Saccharometer Microscope.*—This instrument is shown in Fig. 65, and its special feature (though one of very doubtful advantage) is that it enables one and the same instrument to be used as an ordinary Microscope and as a saccharometer.

The following is the method of using it:—The diaphragm having been removed from the stage *t*, and the polarizer *p* substituted, the body-tube (with eye-piece and objective) is taken out of the tube *r*, and the saccharometer-tube *sr* inserted so that its lower end is close over the polarizer. The latter tube has at its upper end, and on one side, a semicircle *sk* fixed at right angles, on which is a scale graduated up to 25° from the centre on either side. The analyzer *aa* is inserted, and the mirror *s* arranged in the usual way for microscopical observation. The nonius *n*, attached to the analyzer, is then adjusted by turning the latter so that the centre division of the nonius exactly agrees with the 0° of the scale, and the polarizer is revolved on its axis to the right or left until the so-called neutral point is reached, at which both halves of the field of view appear of equal intensity and colour. Removing the analyzer, the glass cylinder *g* (20 cm. long) is inserted into the saccharometer-tube (being first completely filled with clear solution of sugar or urine), and the analyzer replaced in its original position. On revolving it to the right or left until the neutral point is again reached, the nonius will now have another position on the scale, and its central division marks the degree, from which the percentage of sugar in the solution can be determined. A petroleum lamp is the best for the observation. The glass cylinder *g* must be completely filled, so that after being closed by the cap *k* there are no air-bubbles.

Fig. 65.



The scale (not divided into 360° but into 180°) shows the quantity of glucose or grape-sugar direct.

* Cf. Hager, H., 'Das Mikroskop' (8vo, Berlin, 1879), pp. 45-7, 1 fig.

Wenham's Universal Inclining and Rotating Microscope.—"Another F.R.M.S." suggests* that there was one point in connection with this Microscope which has been omitted, and claims that the merit of the principle of construction is due to Dr. Edmunds, on the following grounds:—

"On November 10, 1880, at the Royal Microscopical Society, Dr. W. B. Carpenter exhibited and fully described a small rough stand made for students' purposes by Mr. George Wale, and the record of the proceedings of that meeting will be found in the Journal of the Society for 1880, p. 1087. From that published record I extract the following paragraph:—

'Dr. Edmunds pointed out that this most useful microscope-stand would be vastly improved if only the arc upon which the body turns were so constructed that the centre of the circle of which the arc forms part were made to coincide in position with the centre of the stage. The object would then undergo no movement of translation, either in rotating the stage or in turning the optical tube from the vertical to the horizontal In rotating the stage, the object would turn upon the optic axis; in moving the tube into various degrees of obliquity from 0° to 90°, the object would rotate upon its horizontal axis. The result would be that, with a thin stage and a hemispherical lens in immersion contact with the under surface of the slide, all the complicated swinging substages and other contrivances now upon the table might be swept away, and every angle of illumination could be got by merely inclining the body of the Microscope upon its sustaining arc. There would only be needed a lamp on a level with the object, with a condenser at its focal distance standing upon the table in line between the lamp and the object.'"

The writer, in some criticisms of the design, insists that with the object centered upon a revolving stage and *one* movement in altitude, all possible illuminations are at command.

Mr. Wenham subsequently writes † denying that he had previously read Dr. Edmunds' remarks above quoted, and stating that his own Microscope was designed before their date.

A similar disclaimer is made ‡ by Mr. J. M. Moss, the designer of the Microscope described in this Journal, i. (1881) p. 516.

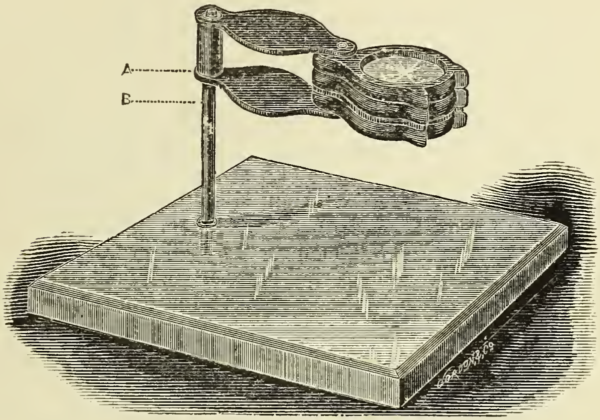
Brücke Lens.—Mr. A. Smith points out, with reference to our description of this lens, *ante*, p. 101, that it is also described in Rutherford's 'Outlines of Practical Histology,' 1876, p. 36, and figured, with a holder, on p. 38.§ Our sectional woodcut, Fig. 14, was unfortunately reversed by the printer.

Bausch and Lomb Handy Dissecting Microscope.—This instrument (Fig. 66) made by the Bausch and Lomb Optical Company, for use in mounting Foraminifera or other objects which have to be

* Engl. Mech., xxxv. (1882) p. 217.
† Ibid., pp. 237 and 282. ‡ Ibid.
§ It is also referred to by Dr. Carpenter, 'The Microscope and its Revelations,' 1881, pp. 58–9.

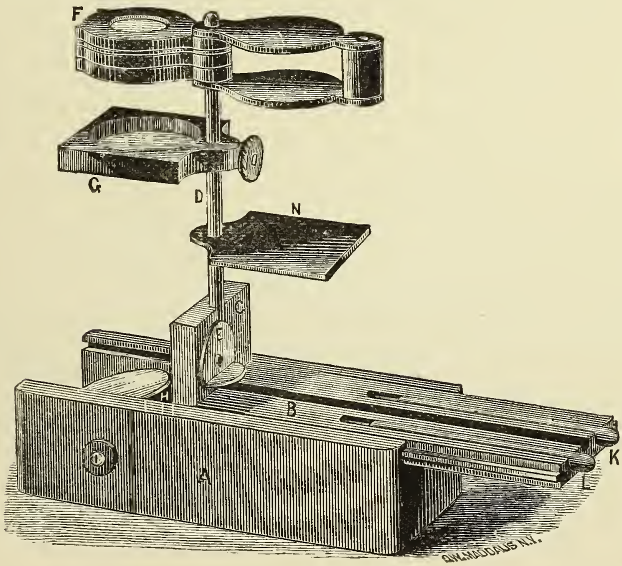
selected from sand and other débris, differs from other similar forms in that the base (into which the steel stem supporting the lens is screwed) is made of a thick plate of glass, so that by placing a sheet

Fig. 66.



of white paper beneath it, and using a bull's-eye condenser, opaque objects can be easily selected for mounting.

Fig. 67.



Excelsior Pocket and Dissecting Microscope.—This instrument patented by J. J. Bausch (Fig. 67) comes from the United States,

where it has been several times described. It consists primarily of a small wooden case A, about one-third larger than shown in the figure. To one end of the lid B is attached one of the ends C of the case, and when the lid is reversed it may be slid into the groove of the case, and then forms a stand for the lenses and stage. These are supported by a steel rod D, the lower end of which is hinged to the lid so that it may be turned down and lie in the groove provided for it. When raised into the position shown in the figure, it is held securely in place by means of the button E, which also serves to retain it in the groove when it is turned down. The glass stage G is fitted into a frame of hard rubber, and slides easily on the stem D, so as to be readily adjustable for focus, while at the same time it may be firmly fixed by means of a set-screw, at any desired height, and will then serve as a stage for dissecting purposes. The frame which holds the lenses F (magnifying 5–30 diameters) fits on the top of the stem. A mirror H is fitted into the case, and is readily adjustable by means of the button I shown on the outside, so that light may be reflected up through the stage when the objects to be examined are transparent. When they are to be viewed by reflected light there is a dark plate of hard rubber N, which is also carried by the stem D, and may be turned under the stage so as to cut off all transmitted light. Dissecting needles (K and I), with handles, fit into appropriate grooves.

The glass plate is fitted into the stage so as to form a cell capable of holding water, so that dissection may be carried on under that liquid, or aquatic animals may be kept alive and examined at leisure. The stage may also be turned so that the flat side will be uppermost if desired. When the lenses and stage are removed they are readily packed in the case, and the entire instrument goes into a compass "which readily admits of it being carried in the vest pocket."

Dr. Phin recommends * that in order to increase the steadiness of the instrument the case should be attached to a board 6 in. × 4 in. × $\frac{3}{4}$ in. A single small screw is sufficient, and the board can be easily detached when it is desired to carry the Microscope in the pocket.

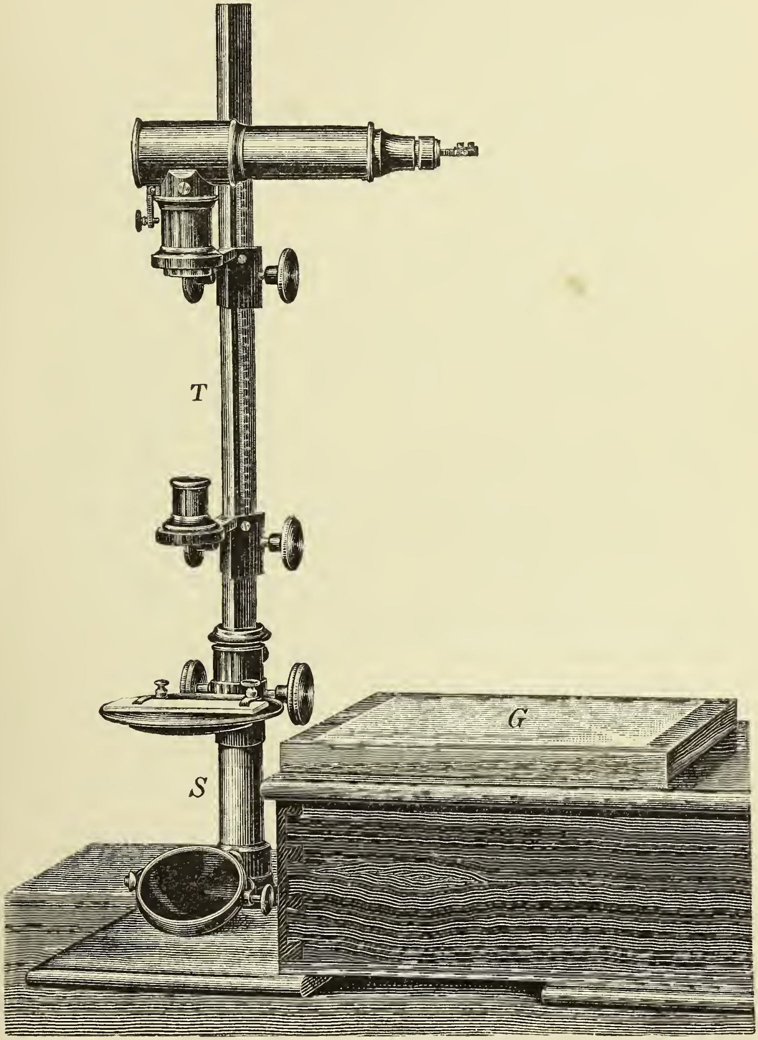
Hartnack's Drawing Apparatus (His's Embryograph).†—Dr. E. Hartnack describes his new drawing apparatus, which is a modification of the embryograph of Professor His. He writes:—"It is desirable for many purposes of natural history to trace exact outline drawings with low magnifying-powers, and to be able to regulate the power so that it may be easy to pass from one scale to another. The drawing apparatus hitherto employed in microscopy (even with the use of low objectives) have hardly allowed the use of a power less than 20; moreover, although through the movement of the tube it was not impossible to obtain any scale desired, yet, at any rate, it was not convenient.

"A short time ago Professor W. His published ‡ the design of a drawing-apparatus which allowed the power to be varied at will from 4 to 40. He combined the Oberhäuser camera with a small photo-

* 'How to use the Microscope,' 4th ed., 1881.
† Zeitschr. f. Instrumentenk., i. (1881) pp. 284–7 (1 fig.).
‡ 'Anatomie menschlicher Embryonen,' fol., Leipzig, 1880.

graphic objective in such a manner, that both could slide backwards and forwards in movable sockets, on a bar 60 centimetres long, provided with a scale. The bottom of the bar bears the movable

FIG. 68.



object-stage, and under this is a microscope mirror. A glass plate placed at the side of the apparatus acts as the drawing surface.

"This apparatus has been employed for years by Professor His, but I have endeavoured to give it a more compendious form, and at

the same time to extend its magnifying power still more. In this I have succeeded by employing different objectives for the lower and higher powers, so that it was possible to reduce the height of the apparatus by a third."

The accompanying figure shows the apparatus (Fig. 68), S being a circular column, and T an angular bar, the latter divided into millimetres. G is the drawing plate placed on the box ($38 \times 22 \cdot 5 \times 9 \cdot 5$ cm.) in which the apparatus packs by separating the pedestal, column and bar, the stage, &c.

Professor His writes to Dr. Hartnack as follows as to the use of the apparatus:—"Your form is thoroughly serviceable, and allows of correct and convenient working with powers of 4 to 70. According to your request I append some information as to its management. The regulating of the magnifying power is the first thing to be attended to by means of a scale divided into half-millimetres as an object. The stage must be placed in its highest position, and the objective and the prism moved until the image projected upon the glass plate shows the desired magnifying power. . . .

"For a power of 4, the stage must be pushed downwards 20 mm., and in order to take in the whole of the field of view with powers of 4 or 5 it must be unscrewed from its ring and the latter used as the stage.

"The aperture of the stage is only 20 mm.; short or long-sighted people should always use the same spectacles. When the desired power has been determined the object to be drawn is placed on the stage, and focussed *only* by moving the latter. In order to obtain a distinct image, the object must be in the same plane as the numbers and strokes of the scale were previously, and if this is obtained by unaltered position of the objective and prism, the magnifying power of the whole apparatus must remain the same as before, the distance of the drawing-surface from the objective remaining unchanged."

[Some general remarks follow as to testing the objectives, the regulation of the light, &c.]

"Opaque objects are best drawn in liquids. My chief object being to draw embryos, I have had unpolished hollow vessels of black glass or marble made, 5–20 mm. in depth; the embryos were covered with alcohol and a thin glass plate placed over them in such a manner as to exclude air bubbles. If it is necessary to keep the embryo in a given more or less depressed position, this can be done by using small strips of glass suitably bent.

"The above directions will perhaps suffice to assist the inexperienced in the use of the apparatus, and I only hope that others may find it, in the elegant and convenient form which you have given it, as useful as I have done."

Drawing from the Microscope.*—Mr. W. T. Suffolk dispenses entirely with the camera lucida, and substitutes a grating ruled in squares and placed over the diaphragm of the eye-piece. It is better

* Sci.-Gossip, 1882, pp. 49–50.

to have the lines ruled on a double-convex lens of shallow curvature, as the interference with the definition is considerably less than when a glass with plane surfaces is used: with this arrangement Podura-markings can be well shown with a $\frac{1}{8}$ objective. When the binocular is required, a lens without ruling, but of similar curves, should be placed in the other eye-piece to equalize the magnifying power in each field. A convenient distance for the lines is $\frac{1}{20}$ inch, this gives a field not too much crowded with squares, and on the other hand the divisions are not too large to render the setting out of the outline inexact. The drawing is made on ruled paper, the squares being of a size suitable to the intended size of the design, just as in the well-known draughtsman's process of enlarging and reducing by squares. A drawing of any size, from a small sheet to a large lecture diagram, can thus be made directly from the Microscope.

The process also possesses the additional advantage of requiring no change in the position of the Microscope, as is the case with the camera-lucida, and can be used for a long time without any of the strain upon the eye inseparable from the use of instruments, where the image and pencil point are viewed through the divided pupil of the eye.

With regard to materials, Mr. Suffolk takes exception to the use of *flake white* for compounding body colours, as in water all pigments made of carbonate of lead rapidly become blackened. Chinese white, a preparation of oxide of zinc, should alone be used for this purpose. He also gives the following list of colours which he considers will be found sufficient for nearly every purpose:—aureolin,* yellow ochre, lemon yellow, cadmium yellow, vermilion, purple madder, raw sienna, burnt sienna, rose madder, light red, brown madder, cobalt, French blue, indigo,† vandyke brown, blue black, sepia, viridian.‡ In addition to the colours in cakes, a few that are likely to be used in large quantities should be obtained in tubes; where thick painting is required, this form of colour is particularly useful. The Chinese white should be kept in a bottle with a greased stopper; in tubes it soon hardens and becomes unfit for use; it should be worked with the palette-knife and a little water to the consistency required.

The use of crimson and purple lakes, carmine and all other cochineal colours should be avoided; the madders are the only safe substitutes. Iodine, scarlet, the chrome yellows, and all aniline colours, should find no place in the colour box.

Very good effects are obtainable by the use of blacklead, and

* Aureolin, a transparent pure yellow, quite permanent, and an excellent substitute for gamboge, as, being without gloss, it can be employed in skies and distances.

† Indigo is only very slowly acted upon by light, and may be considered permanent in the diffused light of an ordinary room; avoid mixing with Indian red, which speedily destroys it.

‡ A transparent oxide of chromium, perfectly permanent, of great use both by itself and in compounding other greens; the opaque oxide of chromium may also be found useful; both are extremely permanent colours.

for rapid work it offers many facilities. In addition to pencils of the usual kind, some with broad leads will be found useful for covering larger surfaces. Very delicate tints can be made with blacklead powder rubbed on the paper with a suitable leather stump. Tints of any depth can also be obtained from blacklead used as a water-colour, which can be procured in cakes.

Blacklead, charcoal, and chalk drawings can be permanently fixed, by saturating the paper from behind with a varnish composed of bleached shellac and alcohol. This should be very freely applied and dried in a warm room or with caution before a fire. The strength should be such that it will just dry without leaving a gloss on the paper. Winsor and Newton's white lac varnish, mixed with an equal bulk of methylated spirit, will be the right strength. After this treatment a pencil drawing may be placed in the portfolio, and even exposed to some amount of rubbing, without injury. The varnish does no harm to any water-colour tints that may be used in combination with pencil.

Ulmer's Silk Thread Movement.*—J. Ulmer suggests the use of a silk thread for microscope-tubes and the eye-pieces of telescopes.

The tube T (Figs. 69–72) has above and below in the socket two guides *c c*, against which it is gently pressed by the small pulley *d* and spring *e*, by which means easy sliding is secured. The movement of

FIG. 69.

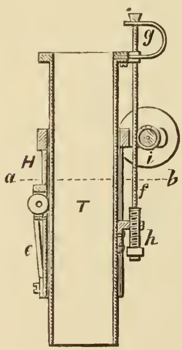


FIG. 70.

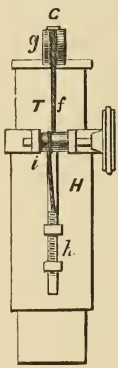


FIG. 71.

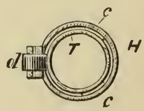
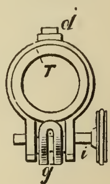


FIG. 72.



the tube is effected by the silk thread *f* which is attached to a spring *g* and screw *h*, both of which are fixed to the tube. The spring is slit as shown in the figures, and the screw is hollow and serves for stretching the thread and the spring, after the former has been laid in the slit, and turned round the pinion *i*, which is fluted to avoid slipping. The rotation of the tube is prevented by making the support by which the female screw at *h* is attached to the tube slide in a slit in H.

The apparatus works, it is said, without any "loss of time," and secures an easy motion, at the same time being very simple.

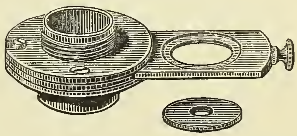
* Centralztg. f. Optik u. Med., ii. (1881) p. 148 (4 figs.).

Diaphragms for Limiting the Apertures of Objectives.—Mr. J. B. Dancer proposes * other forms of diaphragms for this purpose, the iris-diaphragm being unsuitable on account of the "ragged" outline which it gives. The first form is an oblong plate of diaphragms, which *slides* in an adapter screwed to the nose-piece, the second is a circular *rotating* plate.

The third method utilizes the ordinary double nose-piece. A shallow recess is made in the top edge of one of the female screw parts of the nose-piece to receive thin metallic (numbered) disks, having holes of suitable diameters. A disk with the required aperture can be dropped into the recess by merely moving the arm, which carries the objective, on one side. A wire hook is useful for lifting them out again.

A still later device is shown in Fig. 73, and is a combination of the first and third plans. An oblong plate slides in an adapter, but instead of being pierced with several apertures of different sizes, it has two apertures of equal size, into which can be dropped the various diaphragm disks used with the third plan. This gives great facility for removing and changing the diaphragms quickly, and might, we think, be usefully adapted for taking the diaphragms required for the diffraction experiments.

FIG. 73.



It must be observed, however, that the object for which the use of these diaphragms was suggested is not practically attainable. The suggestion was founded on the fact that a low-angled objective has greater penetrating power than a high-angled one, and it was considered that by using a diaphragm at the back of the objective, thus cutting down the aperture, an objective of wide aperture could be made to do duty as a narrow-angled one also, so that two classes of objectives were unnecessary. As Professor Abbe points out at p. 308, the plan adopted in the construction of wide-angled objectives will not allow of such a double use; and it is still necessary to employ two classes of objectives, using those of small aperture when penetration is required.

Correction-adjustment for Homogeneous-immersion Objectives.†—Dr. G. E. Blackham discusses the reasons suggested for dispensing with an adjustment to these objectives, viz. no risk of decentering, the existence of a *one best* position in all objectives, the cost of the adjustment, and the trouble of correcting.

To these objections the following he considers to be conclusive replies.

First, if the brass-work is done with a degree of skill at all commensurate with that necessarily expended on the glass-work of a really first-class homogeneous-immersion objective, there need be no fear of injurious decentering by the movements of the adjustment-collar.

Second, while it is true that the adjustment by means of varying

* North. Microscopist, ii. (1882) pp. 89–90, 92.

† Proc. Amer. Soc. Micr., 1881, pp. 61–4.

position of the systems is only an expedient, yet if it can be shown that it reaches the desired end more certainly, speedily, and accurately than any other, the objection to it must fall to the ground.

Third, that while it is conceded that really first-class metal-work is expensive, if it can be shown that it is *necessary*, the objections to it must also fall.

The term homogeneous-immersion, though honestly applied and correct as to the *idea*, is only approximately true at present, as no truly homogeneous-immersion fluid has as yet been discovered, so far as the author can learn. That is, no fluid whose optical properties are *absolutely identical* with those of the front lens of any objective. The *refractive* power of crown glass has been closely approximated, but minute differences of *dispersive* power remain; and even if this difficulty could be overcome, the varying refractive and dispersive powers of various samples of crown-glass must always remain an unknown quantity in our problem, to be provided for by some kind of adjustment.

This fact has been recognized by at least one maker, who advises to correct for extremely thick or thin covers, by means of the draw-tube, and furnishes *two* fluids, one for use with direct central light, and the other with very oblique light. Of course it follows that for perfect accuracy of correction by means of the immersion fluid, a different fluid would be needed for each degree of obliquity of illumination. That this would involve serious inconvenience hardly needs demonstration; more especially when we consider that it is often desirable to examine an object under *gradually* varying obliquity of illumination, from direct central to the most oblique the lens can utilize.

Another point is the variation in the human eye; which must be compensated for in some way.

"It appears then, that the homogeneous-immersion system does not entirely obviate the necessity for adjustments of some kind, though it greatly lessens their *extent*. That these small residual adjustments can be made with more ease, rapidity, and accuracy by means of the screw-collar moving the back system of the objective, than by means of varying the distance between the objective and eye-piece by means of the draw-tube, or by varying the refractive and dispersive powers of the immersion medium by means of mixtures of various oils, &c., in varying proportions will, I think, on consideration be generally admitted.

But this greater ease, rapidity, and accuracy of adjustment with homogeneous-immersion (so called), is not the only argument in favour of the retention of the adjustable mounting for objectives. Most immersion fluids are apt to vary in their optical properties with their age or the state of the weather. One of the best of them, the solution of the sulpho-carbolate of zinc in glycerine, has its refractive power increased in very dry and decreased in very wet weather. In this case it is more convenient to turn the adjustment-collar slightly, than to make a new solution for immersion.

Again, it is often desirable to use an objective with a much longer

or shorter tube than it was specially constructed for, or to use some other immersion medium than its own, water or glycerine for instance, for some special purpose. Here, again, the advantage, nay, the necessity, of the adjustable mounting, becomes evident. I believe then that I have shown :—

First, that homogeneous immersion has not been and is not likely to be more than approximately attained.

Second, that even if it should be fully attained, so far as the front lens of the objective is concerned, the varying refractive and dispersive powers of different eyes, and different samples of cover-glass would always remain to be accounted for.

Third, hence adjustment of some kind will always be necessary.

Fourth, that a well-made adjustable mounting for the objective is the most convenient, satisfactory, and perfect arrangement for this purpose yet devised.

Fifth, that by means of such an adjustable mounting the range of usefulness of an objective, as well as the convenience of using it are greatly increased, and therefore,—

Sixth, homogeneous-immersion objectives (so called or real), as well as all other objectives of wide angle, should be made adjustable."

Hitchcock's Modified Form of Vertical Illuminator.*—Professor R. Hitchcock suggests another form for a vertical illuminator, which, he thinks, will be better than the ordinary one, and more convenient for use.

"Instead of the reflector now used, a small glass reflecting prism is placed in the nose-piece in the same way and in the same position as the Wenham binocular prism, and in the case of binocular Microscopes should replace the latter. The back surface of the prism, which receives the light, may be either plane or curved; it might be found advisable to make this surface act as a lens to throw the light upon the back of the objective in the most advantageous manner for illumination. All parts of the prism not used should be blackened, so that no light except what passes down to the objective can enter the tube. A rotating diaphragm can be added, working in front of the exposed surface of the prism; but this would probably be an unnecessary expense."†

Flesch's Finder.‡—Dr. Max Flesch describes the arrangement shown in Fig. 74, as a simple contrivance for finding objects on a slide where a more complicated apparatus is not suitable.

A clip of horse-shoe shape attached by two pins, holds the slide upon the stage. The outer sides of both arms are bevelled off and all four sides graduated. When a particular object or part of an object is in the field a line is drawn with a pencil along both sides of each arm crossing the slide. The numbers of the divisions are also marked on the slide with short cross lines, as shown in Fig. 75. If the slide is again brought into its original position, as determined by the

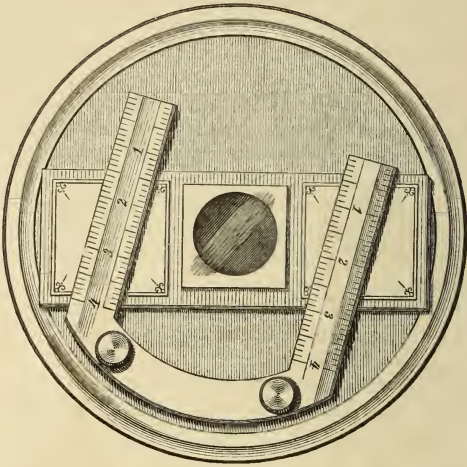
* Amer. Mon. Micr. Journ., iii. (1882) p. 54.

† Mr. J. W. Stephenson informs us that he had a vertical illuminator on this plan constructed in 1879.

‡ Arch. f. Mikr. Anat., xx. (1882) pp. 502–3 (2 figs.).

coincidence of the arms and divisions of the clip with the lines on the slide, the object will necessarily be in the field of view. The

Fig. 74.



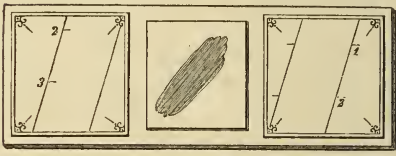


Fig. 75.

arrangement has been found sufficient for an *Hipparchia* scale, with a power of 150.

Burnett's Rotating Live-Box.—This is thus described by Mr. R. T. Burnett, its designer:—"The arrangement of this live-box is very simple. Hitherto live-boxes have had the outer cases, which hold the strong or bottom glass, screwed into, or fixed firmly to, the plate that goes upon the stage. This one is constructed so that the outer case fits into a flange or cylinder its own depth. The cylinder is made fast to the plate, leaving the outer case, together with the inner case, free to be rotated at the will of the manipulator, forming, in point of fact, an ordinary live-box resting within a deeply flanged plate.

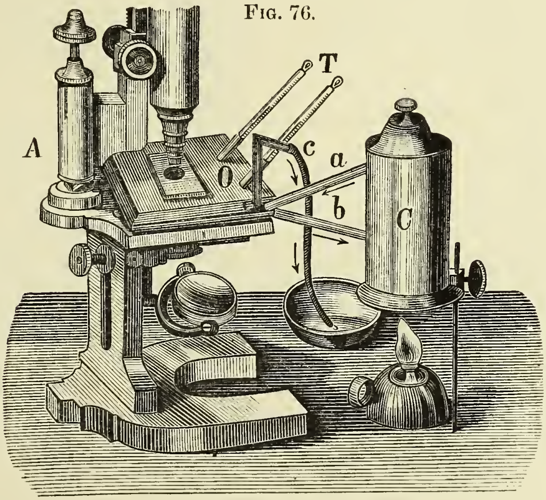
In using the ordinary live-box, it has hitherto been necessary to take it off the stage whenever the observer has been desirous of turning the object round, or when, in the absence of an 'erector,' it has been necessary to have an object which has been placed head downwards changed to an upright position. This is avoided by the rotating live-box.

Further, in using the ordinary live-box with high objectives, the latter will project within the rim of the live-box; consequently no such

change could be made without altering the focus of the Microscope, and causing a loss of time in readjusting the focus and in finding the particular part of the object. By the rotating live-box no alteration of the focus is necessary."

Schklarewski's Hot-water Stage.*—This is represented in Fig. 76. The water, heated by gas or a spirit lamp, passes from the vessel C, through the tube *a*, into the hollow stage O placed on the microscope-stand A. A thermometer T shows the temperature. The

Fig. 76.



water, after passing through the stage and becoming cool, flows back again through *b* into the vessel C, whilst that which is more heated flows through *c*, and the indiarubber tube attached to it, into another receptacle. The stage does not appear to differ essentially from other well-known forms.

Abbe's Condenser.—This apparatus as originally devised † was not easily applicable to any stand but that of Zeiss for which it was specially made. It has now been so modified (Figs. 77 and 78) that it can be applied to the usual substage fitting.

The upper lens A is a thick plano-convex, somewhat larger than a hemisphere. Just below it is a large bi-convex lens serving as a collecting lens to A. The upper focus of the combination is about 2 mm. (in glass) above the plane face of A, that is, about the distance of an object on an ordinary slide. A small metal cap with a central pin-hole can be placed over A for convenience of centering. B is a box-fitting for diaphragms, &c., forming part of the carrier-plate C,

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 88–9 (1 fig.).

† Mon. Micr. Journ., xiii. (1875) pp. 77–82 (1 fig.).

made to rotate immediately below and in the axis of the optical combination. The carrier-plate moves laterally by rackwork acted upon by the toothed pinion D. To facilitate changing the diaphragms C can be swung out of the axis on the swivel-joint E, as shown in

Fig. 77.

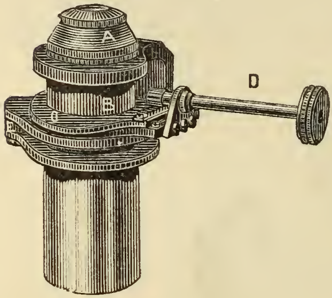


Fig. 78.

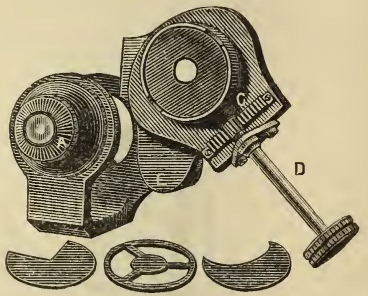


Fig. 78. Circular, lune-shaped, and other diaphragms are supplied, which give a large variety of effects of obliquity both in altitude and in azimuth when used with the lateral and rotating movements of C. For black-ground illumination a central stop is placed in B, and Zeiss supplies special diaphragms to be applied at the back of several of his objectives of large aperture which ensure the dark-ground when used in conjunction with this condenser. With objectives of greater aperture than 1·0 N.A. the condenser must of course be in immersion contact with the base of the slide. The condenser has a numerical aperture of 1·4 nearly.

Bausch and Lomb's Immersion Illuminator.—This illuminator (of which we have no drawing) is intended "to utilize the full capacity of medium and wide angle objectives," up to 152° in crown glass or 1·47 N.A. Its mounting is arranged with an internal diaphragm, which is placed directly under the posterior system of lenses, and entirely contained in the tube comprising the mounting, so as to avoid the projection existing with other condensers, and allows the light to enter only from below. By revolving the milled ring of the mounting, the diaphragm is made to pass laterally from the centre to the extreme edge of the illuminator, thereby projecting a bundle of rays of any obliquity, between 0° (central illumination) and the extreme possible limit 1·47 N.A. When the diaphragm is at its extreme, a second slit, at right angles to it, giving the same volume of light, is opened by the further movement of the milled ring. The makers add that "the fact that it is used with only central illumination of the mirror, will prove especially valuable to those who do not possess instruments with the modern swinging substage and mirror bar."

Bausch's Paraboloid.*—Mr. E. Bausch describes a new form of paraboloid in which the hemispherical hollow in the top is left clear,

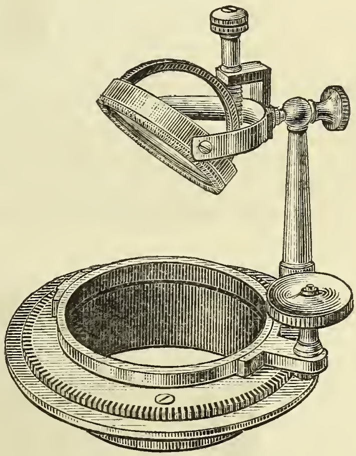
* Proc. Amer. Soc. Micr. 1881, p. 88.

there being a blackened brass cup to fit into it when desired. A hemispherical glass lens fits in the same hollow, " optical contact " being made between the paraboloid and the lens by glycerine and a homogeneous medium. There is also an opening in the side for the admission of light, all other light being stopped out.

The apparatus can thus be used as a Wenham reflex illuminator or an ordinary paraboloid, at the same time providing a hemispherical lens if required.

Browning's Simple Heliostat.—Fig. 79 shows a simple form of heliostat for the Microscope. It is provided with three movements:—(1) The rotation in the vertical plane of the inner cylindrical fitting, carrying the mirror arm, on the fixed toothed disk, by the large milled head; (2) The inclination of the mirror in the double gimbal fitting by means of the endless screw (milled head to the right) acting upon a countersunk worm on the posterior sector forming the inner arc of the gimbal; (3) The rotation of the entire gimbal-mounting of the mirror by the milled head beneath (this movement serving principally for the first adjustment of the mirror to the direction in the horizontal plane in which the reflected beam is to be utilized).

Fig. 79.



The particular heliostat figured was adapted for mounting in the substage of a Microscope which in that case would have to be inclined so that the optic axis is parallel with the pole of the earth. The mirror being then adjusted to the direction required, the beam of reflected light would be maintained on the same spot by the simple rotation of the mirror arm on the toothed disk, acting as the hour circle of an equatorially mounted telescope, the inner gimbal arc acting as the declination circle.

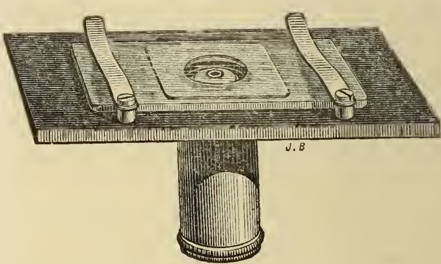
It can also (and probably better), be mounted vertically upon a separate stand apart from the Microscope, or in a shutter exposed to a southern aspect.

Hayem and Nachet's Modified Hæmatometer.—This is now arranged as shown in Figs. 80–82, and is thus described by M. Nachet:—

" The hæmatometer, formed of a cell with a flat base, devised by Dr. G. Hayem and myself some years ago, has been adopted by the different authors who have experimented on the number of the blood-corpuscles. Some modifications have been made in the apparatus, without changing it essentially, amongst which may be noted the

attempt to do away with the eye-piece micrometer ruled in squares. Drs. Thomas and Gowers suggested engraving the lines on the base of the cell itself, an eye-piece micrometer being replaced by an objective micrometer. It is, however, in the first place, nearly impossible to

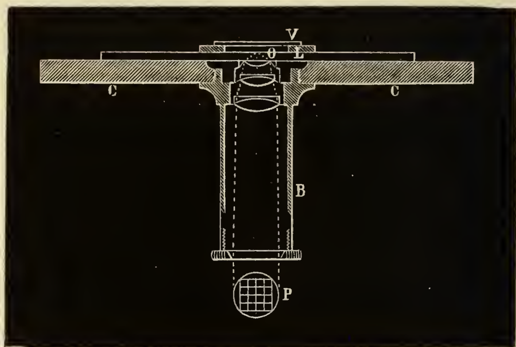
Fig. 80.



engrave lines as fine as are required on such smooth and polished glass as that of which the cell is made, so as to be clearly visible; there is also the risk of breakage, &c., and the inconvenience that when the cell is filled with the liquid, the lines are still fainter and unsuitable for being easily seen.

The new arrangement consists of a metal plate C C, to which a

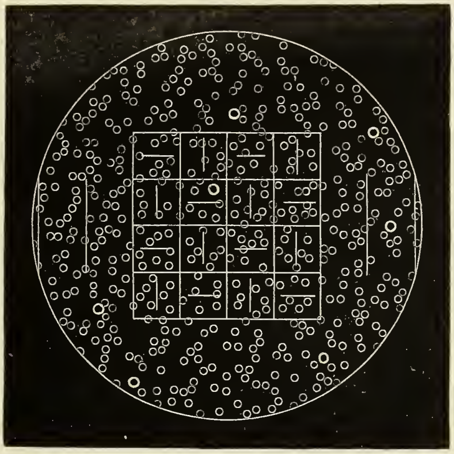
Fig. 81.



tube B, about 20 mm. long, is screwed, containing on its upper part a system of lenses, intended to form a very small image of a set of divisions P in squares, engraved or photographed on glass, and placed at the lower end of the tube. The tube is introduced into the opening of the stage, and on the plate C C is placed the cell of the hæmatometer, containing the liquid with the globules in suspension. These soon fall to the bottom plate of the cell, and the focus of the lenses being exactly upon this plate at O, the image of the squares P is formed there and is visible through the Microscope, at the same time as that of the globules (see Fig. 82).

By this means all the inconveniences attendant upon engraving the divisions at the bottom of the cell are avoided. The divisions may be as exact and as strongly marked as possible, the image

Fig. 82.



depending entirely upon the intensity of the photograph and its size on the reciprocal distance of P and O."

Fasoldt's Test-plate.*—Professor R. Hitchcock does not consider that the diffraction spectra alleged to have been seen by Mr. Fasoldt are any proof of the presence of the separate lines claimed, and "would like Mr. Fasoldt to inform us how fine the individual lines of his wonderful plate are? If the plate has 1,000,000 lines to the inch, the individual lines cannot be broader than half a millionth of an inch. Can such fine lines be ruled? Then it is a question in mechanics, whether a tool can be made so steady that it can draw a line without a tremor of half a millionth of an inch—for if not, then the lines of the plate must run together.

"In regard to the first question, there is already some evidence that Mr. Fasoldt's assumption is not justified. Professor W. A. Rogers ruled a plate with his machine set for 500,000 lines to the inch, making every fifth and tenth line longer than the rest. He then measured the long lines, where they projected from the band, and found that they were so broad, that they overlapped each other, leaving no spaces between them. Evidently, therefore, the band of 500,000 lines did not consist of distinct lines. The spectra were, nevertheless, clear and bright. Hence, we are forced to conclude that the spectra do not prove that Mr. Fasoldt's plate contains 1,000,000 lines to the inch."

We have not seen Mr. Fasoldt's claim as to the diffraction spectra

* Amer. Mon. Micr. Journ., iii. (1882) pp. 52–3.

and do not know how it is worded, but however worded any such claim must originate in a very strange misconception.

The number of lines to an inch capable of being resolved are defined by the equation

$$\delta = \frac{1}{2} \frac{\lambda}{n \sin u}.$$

Taking λ for simplicity at $\frac{1}{50000}$ inch (instead of ·5269 μ), and u to be 180° (sin u being = 1), it will be seen that for δ to give 1,000,000 lines to an inch, n—the refractive index of the immersion medium (and with it the objective and the test-plate)—must be made of a substance whose refractive index is 10. What is this wonderful substance—the philosopher's stone of the microscopist?

Or to put the same point in another way:—

The diffraction spectra of lines 145,000 to the inch, can only just be got into the back lens of a homogeneous-immersion objective of 1·50 N.A. To get in the diffraction spectra of 1,000,000 to the inch, the aperture must have been not less than 10 N.A.! How has this aperture been obtained at a time too when we are congratulating ourselves on having reached 1·47 N.A.?

The visibility of the diffraction spectra, so far from proving the existence of lines at the rate of 1,000,000 to an inch, is conclusive proof that they do *not* exist, and that nothing beyond 150,000 at any rate could have been observed.

High Resolving-power.—We have been referred to what is termed a claim of Dr. T. S. Up de Graff to have resolved lines as fine as 152,400 to the inch. Dr. De Graff's statement is, however, simply that he has resolved the last band of Fasoldt's 19-band plate, and he is careful to add "152,400 to an inch, the number of lines *claimed* by the maker to be ruled in this band" (italics in original). While, therefore, fully accepting the observer's statement that the lines which he did resolve were true and not spurious lines, we have, of course, to wait for the demonstration that the maker's claim is correct before commencing again, with clean boards, to endeavour to establish a theory of resolution! The theoretical resolving power of the largest apertured lens yet made (Powell and Lealand's 1·47 N.A.) is about 141,500 lines to an inch.

Binocular Microscopes.*—Professor R. Hitchcock, in discussing the question whether there is any real advantage in binocular over monocular instruments, thinks that the problem is a very difficult one if we attempt to decide on theoretical grounds what effect any particular binocular arrangement will have when applied to the examination of a specified object; to explain how much of the appearance of relief is real, and how much is merely a mental impression produced by the two images in the two eyes.

He, therefore, prefers to confine the discussion to the practical side of the subject. "If the question is whether there is any advantage in a binocular Microscope in studying the form of objects—

* Amer. Mon. Micr. Journ., iii. (1882) pp. 45–8 (8 figs.).

whether the appearance of relief that it gives is necessary to enable us to form a correct idea of the true shape of objects in which the appearance of relief is most striking—the answer must be a decided negative. It is true that the binocular does reveal more of the form of an object at the first glance than the monocular; but it is a matter of experience that those who use only one eye in microscopical work, never make the mistake of supposing that an object is flat merely because it seems to be so. A very short experience enables one to form a perfectly correct idea of the shape of any object by a few turns of the focussing screw. Hence, persons whose means are limited, and who desire to invest a small sum of money in a Microscope to be used for purposes of study, would do well to forego any thought of purchasing binocular stands.

"On the other hand, there are certain qualities of binoculars which commend them to all workers who can afford the additional cost. Apart from any stereoscopic effects it is doubtless true that the use of two eyes whenever possible renders continued observation less tiresome than when only one can be applied to the tube. Some writers have stated that with a monocular one eye is overstrained while the other is not used at all, contending that by using the binocular that trouble is overcome. The two eyes should be used alternately with the monocular, hence they ought to become trained for sharpness of vision, but we doubt if the binocular aids in the way assumed, for we are inclined to believe that although both eyes are simultaneously employed with the binocular, the right eye does most of the real work, the left eye only supplementing its fellow and giving the binocular effect. However this may be, there is a certain ease in working with binoculars which doubtless makes the strain upon the eyes less than with monoculars.

"The stereoscopic effects, while not of great practical importance as already stated, certainly render many objects more attractive to look at. For this reason a Microscope for the entertainment and instruction of friends should certainly be a binocular."

Mr. G. E. Fell also discusses the binocular Microscope and stereoscopic vision,* and the objections that have been made to such instruments, at the same time describing the Powell and Lealand, Nachet, Wenham, Tolles, H. L. Smith, Abbe, and Barnard forms. He is inclined to believe that a trifling temporary defect in the faculty of consentaneous focalization may be produced by the continued use of one eye with the monocular, so that the microscopist may be really incapacitated for realizing the advantage or effect of stereoscopic vision with the binocular, but he does not agree that the convergence of the tubes produces an unnatural straining of the lateral recti muscles, as the angle of that convergence is about equal to that of the eyes in ordinary observation at 10 to 12 inches.

Professor Hamilton L. Smith† prefers the Nachet binocular, though he considers that the Wenham binocular "is beautifully simple in theory and, except for one thing, perfect in practice. The one great

* Proc. Amer. Soc. Micr., 1881, pp. 69–83 (8 figs.).

† Ibid., pp. 89–91.

fault is it necessitates a very quick convergence of the optical axis. . . . With young eyes and nominally sound this difficulty is not distressing, but for older eyes it becomes annoying. Always upon looking up after using Wenham's binocular, for a while he had found an unpleasant feeling of readjustment of the eyes to the normal condition." He also thinks that "a trained eye would make out about as well and with less trouble the actual structure of any object under examination with the monocular as with the binocular—at least such was his own experience offered with much diffidence. For his own special work with high power and wide angles they are not really suited, but others engaged in another line of investigation requiring only medium power and low angles may find them serviceable."

Electric Light in Microscopy.*—Dr. H. Van Heurck describes his experiments with the electric light, commencing by pointing out that, notwithstanding the perfection of homogeneous-immersion objectives, which show readily delicate details, it frequently happens that the study of diatoms (particularly the small forms) gives considerable trouble, as well by the difficulty of resolving the striæ as by the impossibility of counting them with a low power. It is necessary, therefore, to have recourse to a high power, or even to monochromatic light, which is not always possible, as the sun is frequently hidden, particularly in winter. He has, therefore, for some time thought of the electric light for illumination with the Microscope, and his experiments have demonstrated that the incandescent electric light supplies the illumination *par excellence* which the microscopist requires.

The author then proceeds to treat of the *production* of the electricity, referring to the fact that in a probably near future the inhabitants of large towns will have electricity distributed at their doors, so that the necessities to be met will be principally those of microscopists who live in the country or in small centres. Two modes are at present open for the production of electricity, dynamo-electric machines and batteries. The former are, however, out of the question for the purpose under consideration, a small battery being capable of supplying all that is required at a small expense and little trouble.

As to the different forms of batteries the Bunsen is the most powerful, but the vapours which it gives off, and other points, render it unsuitable for microscopical purposes. In his original paper the author recommended the Tommasi battery, a modification of the former, as in every way preferable and cheaper, giving at the same time a full and detailed description of it, with woodcuts. He has since written us, however, that the battery of E. Regnier is still better and the Tommasi has been discarded. The former is thus described in a supplementary note:—

The Regnier battery has modified Daniell elements with very large surface. They consist of a narrow rectangular cell in copper ($45 \times 23 \times 5\frac{1}{2}$ cm.) within which is a zinc plate, closely enveloped

* Bull. Soc. Belg. Micr., vii. (1882) pp. lxii.–lxxiii. (3 figs.).

in a diaphragm of vegetable parchment, and then sewn up in a linen cloth. The cell is filled with pure water, and 400 grammes of sulphate of copper placed in the upper part. Thus charged, the battery will act during 24 hours, and these may be taken either all together or at different times, the battery losing nothing of its charge when it is not employed. When the battery is discharged (which may be known by the liquid becoming colourless) a third of the liquid is removed by an indiarubber tube and replaced by pure water and a new charge of sulphate of copper as before.

The author then treats of the *storage* of the electricity, and gives a woodcut of an "accumulator" made by E. Regnier on the Planté-Faure system. It consists essentially of two plates of lead, coated with a thick layer of minium, separated, wrapped in flannel, rolled upon themselves, and placed in a glass cylinder, well closed, and containing water acidulated with 10 per cent. of sulphuric acid. On leaving off work in the evening a series of these accumulators can be connected with the battery and left until the following evening, and a sufficient amount of electricity will have been stored up for further use.

The third point dealt with is *lamps*. The arc light is inadmissible, and only the incandescent lamps can properly be used. Those not in a vacuum are very good for photo-micrography, but are too brilliant for ordinary work. Of incandescent lamps in a vacuum or rarefied medium (Swan, Edison, and Maxim) the author prefers those of Swan, which can be worked with a force much less than the Maxim lamps. He obtained from Newcastle some special lamps, eminently suitable for microscopical researches, and now employs those exclusively. They are nearly spherical, and are about 3 cm. in diameter, giving a brilliant light with very little expenditure of force. For obtaining a beautiful white light 5–7 Tommasi elements or 3 or 4 accumulators are sufficient. The 4 accumulators will feed the little lamp for more than 12 hours, and a permanent light could therefore be obtained by putting the battery in operation once or twice a week.

The above details refer, as will be seen, to the Tommasi battery. In the note as to the new battery the author only says "for the little microscope Swan lamps, 5 Regnier elements and an accumulator must be employed."

The *advantages* to be obtained from the employment of the electric light by the microscopist are of two kinds, which the author classifies under the head of "Illumination of the Microscope" and "Photo-micrography." As to the first, he says that "The incandescent electric light surpasses all other illumination. It has the softness of a good petroleum lamp, and shows delicate details nearly as well as monochromatic light. The delicate striæ of *Amphipleura* and the 19th band of Nobert's test are seen with perfect sharpness. Professor Abbe, to whom we communicated the result of our researches, attributes it to two causes, 1st, the much greater whiteness of the light; consequently it contains more blue and violet rays. But, as it has been demonstrated by the measurements made by the Professor with different monochromatic lights, that the resolving-power of an

objective of given aperture increases in the same ratio as the wave-length of the light employed diminishes, it follows that the electric light ought to show delicate details more easily than the yellow light of gas or lamps. 2nd. The specific intensity of the electric light being much more considerable than that of other artificial lights, sufficient illumination is obtained with a pencil much narrower than that which must be employed to obtain the same luminous intensity with gas or diffused daylight. Rays much more oblique can therefore be used."

The lamp should be placed in a small box, the cover of which is pierced with an opening. The Microscope is placed on the box, the mirror being turned away from the axis or entirely removed. The light of the lamp is then concentrated by a plano-convex lens and directed into the condenser.

The use of the electric light also allows the microscopist at any moment to photograph an object in the field, and directions are given for proceeding on the dry plate method.

Definition of Natural and Artificial Objects.*—In some "Recollections of my Life," T. Baumann says that the difference between a natural and an artificial object cannot be more briefly or more precisely defined than by saying that under the Microscope the natural object is always more beautiful and the artificial one always more imperfect the more the magnifying power is increased.

Cole's "Studies in Microscopical Science."—Mr. A. C. Cole has projected a weekly periodical under this title "for the use of students, professors and teachers, the medical profession, and others interested in the progress of the natural sciences or engaged in higher education . . . to meet a want, which, even in these days of practical teaching, is felt by every student commencing the study of the natural sciences equally with those who are desirous of devoting their leisure to scientific pursuits.

"It is proposed by means of a carefully prepared and typical object for the Microscope, together with a drawing and descriptive essay, to supply students, microscopists, and members of the medical profession, with a ready means for studying, 1. Microscopical biology in all its branches, 2. The physiological and pathological histology of the body. 3. The essentially modern sciences of microscopical palæontology, mineralogy, and petrology.

"Subscribers will be entitled to receive every week: 1. A microscopical preparation of the highest class and most perfect finish. 2. A printed description of the preparation, in which will be noted: *a.* The literature concerning it. *b.* The habitat, &c. *c.* The methods employed in its preparation as a means of study. *d.* Its principal features, and any necessary additional remarks. 3. A lithographed or engraved drawing, or diagram, of the preparation, in the execution of which the following details will be most carefully considered and adhered to. *a.* Accuracy. *b.* Finish. *c.* Indication of Natural Size, &c.

"The preparations during the first year will consist of a series

* Zeitschr. f. Instrumentenk., ii. (1882) pp. 46–51.

of 26 histological, 18 botanical, and 8 petrological sections issued alternately, and from time to time special subjects will be illustrated by a complete series of preparations with their accompanying drawings and descriptions.

"Announcements will be made for the benefit of special students and practical instruction by this means afforded to those desirous of studying such works as—

Elementary Biology ..	*Huxley and Martin, Parker, &c.*
Practical Histology ..	*Klein, Ranvier, Rutherford, Schäfer, &c.*
Practical Botany ..	*De Bary, Prantl, Sachs, Thomé, Vines, &c.*
Practical Zoology ..	*Claus, Gegenbaur, Huxley, Parker, &c.*
Practical Geology ..	*Geikie, Rosenbusch, Rutley, Zirkel, &c.*

"It is intended that each series when complete shall form a most thoroughly practical work upon the subjects illustrated.

"The letterpress accompanying each series of preparations will afford demonstrations in the special department illustrated, and will thus assist students very materially in their work for university honours, degrees, &c. The drawings and letterpress will be uniform in size, a preface and index will be added, and a suitable case supplied at the end of each year in which the separate numbers can be bound. Small cabinets to contain the preparations, numbered and arranged in such a manner that any object may be readily found on referring to the letterpress (and *vice versâ*) will also be supplied."

The first number, which is before us, deals with yellow fibro-cartilage. After a full description of the specimen, which is a longitudinal vertical section of the pinna of the ear of the cow stained with logwood and eosin, the action of reagents is described. The various methods of preparation which can be adopted for staining and mounting are detailed very fully and completely, and will be found of great practical value. A Bibliography is added in which 37 books and articles are noted. An excellent coloured plate shows the appearance of a section × 333. The second part deals in a similar way with a section of copper beech, stained carmine and iodine green. The plate shows the section × 25.

Mr. Cole's idea appears to us to be an excellent one in every respect, and there is no doubt as to his capability of carrying it out as announced, especially as regards the practical branches of the subject, in which he has acquired a very wide reputation. It only remains for those (and they ought not to be few) who are interested in the success of the scheme to support it.

Journal of the Postal Microscopical Society.—The first number of this quarterly journal has just been issued (56 pp. 9 figs. and 5 plates), containing a considerable amount of useful matter, as will be seen from the following list of contents:—History of the Society; Numerical Aperture; Microscopical examination of Chlorophyll, Inulin, and Protein-crystals; *Tubifex rivulorum*; Diatoms; How to prepare Foraminifera; Lichens. There are notes by Mr. Tuffen West on the slides that have passed through his hands whilst President, and a selection of notes from the Society's note-books, with short notes on preparation and mounting, reviews, apparatus, reports of the Bath Microscopical Society, and Correspondence. If the future

numbers of the journal are equal to the first it will be a very useful one, and should be supported by all the members of the Society.

Aperture Diaphragm. [*Ante*, p. 262.]
Journ. Post. Micr. Soc., I. (1882) p. 51 (2 figs.).

Aylward's (H. P.) Working Microscope.
North. Microscopist, II. (1882) pp. 90–1.

Baumann, T.—Erinnerungen aus meinem Leben, ein Beitrag zur Geschichte der Präcisionsmechanik. (Recollections from My Life, a Contribution to the History of Precision-mechanics.)
[Includes definition of natural and artificial objects, *supra*, p. 420.]
Zeitschr. f. Instrumentenk., II. (1882) pp. 46–51.

Bausch & Lomb Co.'s New Trichinoscope. [*Ante*, p. 258.]
Amer. Natural., XVI. (1882) pp. 429–31 (2 figs.).

Bausch's Homogeneous-Immersion Objectives.
[$\frac{1}{4}$ to $\frac{1}{25}$—140° crown-glass angle—adjustable for water or glycerine immersion.]
Amer. Natural., XVI. (1882) pp. 347.

Blackham, G. E.—Remarks on New Immersion Objectives.
["Do not be troubled or deterred from efforts by 'theoretical limits,' no matter how high the authority that sets them. Newton's dictum as to the impossibility of constructing an achromatic telescope was a stumbling-block in the progress of optical construction and astronomical observation for years, and Mr. Wenham's count of 82° balsam (1·00 N.A.), had it not been disregarded, would have proved an equal barrier in the path of microscopical progress."]
Bausch & Lomb Optical Co.'s Supplement to Catalogue, Feb. 1882, p. 7.

Bolton, T.—Parkes' Class Microscope. [*Supra*, p. 395.]
Journ. Post. Micr. Soc., I. (1882) pp. 52, 55 (2 figs.).

C., F.—Microscopical Club.
[Reply to H. C. S. as to the formation of such a club.]
Engl. Mech., XXXV. (1882) p. 80.

Cox, J. D.—Telescopic Field and Microscopic Aperture.
Amer. Mon. Micr. Journ., III. (1882) pp. 61–9 (3 figs.) p. 76.

Crisp, F.—Notes sur l'ouverture, la vision microscopique et la valeur des objectifs à immersion à grand angle (Notes on Aperture, Microscopical Vision, and the value of wide-angled Immersion Objectives)—*contd.*
[Transl. of paper I. (1881) pp. 303–60.]
Journ. de Microgr., VI. (1882) pp. 143–5, 190–3.

Croullebois, M.—Théorie élémentaire des Lentilles épaisses. (Elementary Theory of Thick Lenses.)
[Geometrical explanation of Gauss's theory—Compound Microscope, pp. 82–3.] x. & 117 pp. (50 figs.). 8vo, Paris, 1882.

D., E. T.—On Drawing and Painting from the Microscope.
[Neutral tint reflector has often been a snare and delusion to young draughtsmen on account of the reversal of the image, which renders it difficult to fill in the drawing from the Microscope afterwards—prefers the Wollaston.]
Sci.-Gossip, 1882, p. 74.

" " The Microscope and Fine Art.
[General remarks on Microscopical drawing and painting.]
Sci.-Gossip, 1882, pp. 97–8.

Dancer, J. B.—On a Method of Mounting the Limiting Apertures for Increasing the Penetrating Power of Objectives. [*Supra*, p. 407.]
North. Microscopist, II. (1882) p. 92.

Davis, G. E.—The Aperture Shutter.
[Further remarks as to the origin of the suggestion.]
North. Microscopist, II. (1882) pp. 88–90 (2 figs.) p. 128.

" " Electric Light for Microscopy.
[Notes as to a trial of the Swan lamp in 1881.]
North. Microscopist, II. (1882) p. 129.

Deby, J.—Apparatus for obtaining monochromatic light.
[The beam of light from the lamp is condensed by a large bull's-eye, passed through a slit, and refracted by a bisulphide of carbon prism.]

DITTMAR, W.—Mikroskopische Ablesevorrichtung für feine Waagen. (Microscopical reading apparatus for fine balances.)
[Recommends a Microscope for reading off the scale.]
Zeitschr. f. Instrumentenk., II. (1882) pp. 63–4.

"English Mechanic" Microscopical Society.
[Suggestions for working the proposed Society.]
Engl. Mech., XXXV. (1882) p. 195.

ERMENGEM, E. VAN.—The Vertical Illuminator.
[Transl. of paper in 'Bull. Soc. Belg. Micr.,' *ante*, p. 266.]
Amer. Mon. Micr. Journ., III. (1882) pp. 48–9.

FLESCH, M.—Einfache Vorrichtung zum Wiederauffinden wichtiger Stellen in Mikroskopischen Präparaten. (Simple contrivance for finding again important points in microscopical preparations.) [*Supra*, p. 409.]
Arch. f. Mikr. Anat., XX. (1882) pp. 502–3 (1 fig.).

" " Ueber einige Verbesserungen an Seibert und Krafft's Mikroskop-Stativ. (On some improvements in Seibert and Krafft's microscope-stand.)
[The tube, instead of sliding in a socket, moves by a pinion on a brass plate, the edges of which slide in grooves attached to the tube (similar in short to the usual English plan). This allows the tube to be more securely fixed and to be raised higher from the stage when low powers are required. The analyzer and polarizer can also be more readily placed in any given relative position. The tube is blackened inside.]
Arch. f. Mikr. Anat., XX. (1882) pp. 504–5.

HARDY, J. D.—On an improved Compressorium.
Journ. Quek. Micr. Club, I. (1882) pp. 35–6, 51–2 (2 figs.).

HEURCK, H. VAN.—La lumière électrique appliquée aux recherches de la micrographie. (The electric light applied to microscopical researches.)
[*Supra*, p. 418.]
Bull. Soc. Belg. Micr., VII. (1882) pp. lxii.–lxxiii. (3 figs.).
Sep. repr. also with additional note on the new Regnier Battery.

HITCHCOCK, R.—Binocular Microscopes. [*Supra*, p. 416.]
Amer. Mon. Micr. Journ., III. (1882) pp. 45–8 (8 figs.).

" " About Stands.
[Reply to query of the Editors of the 'Botanical Gazette,' (". . . Is it a fact that the extra appliances, &c., are more things of 'fuss and feather' than fruitful additions to biological laboratories?") That some accessories are certainly important, but there is a long list of them which embraces many that are quite useless, and very many others that are mere conveniences. Some few are almost indispensable, and Microscopes should be purchased with substages in every case.]
Amer. Mon. Micr. Journ., III. (1882) p. 54.

" " A New Form of Vertical Illuminator. [*Supra*, p. 409.]
Amer. Mon. Micr. Journ., III. (1882) pp. 54, 78.

" " "The Microscope."
[Further remarks as to Prof. Stowell's Journal.]
Amer. Mon. Micr. Journ., III. (1882) p. 58.

" " The Microscope in Medicine.
[Complaint of the want of interest in practical Microscopy among Physicians.]
Amer. Mon. Micr. Journ., III. (1882) pp. 75–6.

" " Ruled Lines as Tests.
[" Resolving power alone is not a test to be depended on."]
Amer. Mon. Micr. Journ., III. (1882) pp. 77–8.

HOLMES, E.—What is the meaning of × ?
[Reply to T. R. J. *infra* who "is confusing himself needlessly." "If a drawing of a man 5 feet high be made 20 feet he is × 4 whether the grain of his skin becomes visible or not."]
Sci.-Gossip, 1882, p. 114.

J., T. R.—What is the meaning of the sign × ?
[Points out the error in describing a drawing as × 500 when it is drawn from an object × 50, and the drawing enlarged 10 times—" unless there be detail corresponding with the amplitude the object is not × so many diameters."]
Sci.-Gossip, 1882, p. 89.

KAIN, —.—Drawing Microscopic Objects.

["Mr. Kain showed (at a meeting of the Camden Society) a method of throwing the image downward by means of a convex mirror, and receiving the magnified image upon a sheet of white paper placed upon the table. It could then be traced without difficulty."]

Amer. Mon. Micr. Journ., III. (1882) p. 59.

KAIN, C. H.—Photo-micrography.

Amer. Mon. Micr. Journ., III. (1882) pp. 71–2, 75.

LOSSNER, O. W.—Telemikroskop (Telemicroscope).

[Abstract of German patent for a combination of a Microscope and a Telescope, D. R. P. 16672, 5th Apr. 1881.]

Zeitschr. f. Instrumentenk., II. (1882) p. 156.

MARTENS, A.—Instrumentenstativ mit Kugelgelenken und Klemmringen. (Microscope-stand with ball joints and fastening rings.)

Zeitschr. f. Instrumentenk., II. (1882) p. 112 (1 fig.).

MATTHIESSEN, L.—Die mittleren Brechungsindices fester und flüssiger Körper im Vergleich mit ihrer Totaldispersion. (The mean refractive indices of solid and fluid substances in comparison with their total dispersions.)

Centr.-Ztg. f. Opt. u. Med., III. (1882) pp. 73–4.

Microscope and Magic-lantern.

[Remarks as to the best objectives by "Sunlight."]

Engl. Mech., XXXV. (1882) p. 202.

MORRISON, —.—Drawing Microscopic Objects.

["Mr. Morrison showed (at a meeting of the Camden Society) an arrangement on the plan of a camera-obscura by which the image was thrown upwards upon a piece of transparent paper placed upon a plate of plain glass."] *Amer. Mon. Micr. Journ.*, III. (1882) p. 59.

Mounting Micro. Lenses.

[Directions by "Prismatique," W. J. Lancaster, and "Micro."]

Engl. Mech., XXXV. (1882) pp. 180, 199, 227.

Objectives and Eye-pieces, best method of determining focal length of.

[Suggestion that Prof. Abbe should give a "short exposition of the subject," with diagrams by Akakia.] *Engl. Mech.*, XXXV. (1882) p. 227.

Objectives, Verification Department for.

[Tabular results of measurements of objectives (*contd.*).]

North. Microscopist, II. (1882) pp. 87, 107, 128–9.

OLLARD, J. A.—Microscopical Drawings.

[Recommends as a simple camera lucida "Forrest's Reflector,"—a thin glass cover adjusted to the eye-piece.] *Sci.-Gossip*, 1882, p. 90.

PINKERNELLE, W.—Apparat zur Erleichterung der mikroskop. Untersuchung von Flüssigkeiten. (Apparatus for facilitating the microscopical investigation of fluids.) *German Patent, No.* 18071, 31*st May*, 1881.

Postal Microscopical Society, History of.

Journ. Post. Micr. Soc., I. (1882) pp. 4–7.

President's Address (*contd.*). *Engl. Mech.*, XXXV. (1882) pp. 213–5.

SCHRÖDER, H.—Ueber Projections-Mikroskope. (On projection Microscopes.)

[Abstr. of original article, *ante*, p. 274.]

Zeitschr. f. Instrumentenk., II. (1882) p. 71 (1 fig.).

VEREKER, J. G. P.—Numerical Aperture.

Journ. Post. Micr. Soc., I. (1882) pp. 7–12 (5 figs.).

WENHAM'S Universal Inclining and Rotating Microscope.

This Journal, II. (1882) pp. 255–7 (4 figs. and 1 pl.).

Engl. Mech., XXXV. (1882) pp. 143–5 (5 figs.).

North. Microscopist, II. (1882) pp. 108–10 (1 pl.).

[Remarks by F.R.M.S., supplementing the previous description, and dealing with (1) general design, (2) fine adjustment, (3) stage, (4) diaphragms and substage centering motions.]

Engl. Mech., XXXV. (1882) p. 195.

[Claim by "Another F.R.M.S." that it is the invention of Dr. Edmunds, and replies by F. H. Wenham, Ross and Co., and J. M. Moss; and further remarks by "Another F.R.M.S.," "Yet Another F.R.M.S.," and "Akakia." *Supra*, p. 400.]

Engl. Mech., XXXV. (1882) pp. 217, 237, 260, and 261.

β. Collecting, Mounting and Examining Objects, &c.

Colouring Living Microscopical Organisms.*—A. Certes points out that distilled and ordinary fresh water are toxic to marine Infusoria, and a great number of species which live in water of very different density and chemical composition.

In these special cases the colouring of *living* Infusoria will not succeed, or only very imperfectly, unless care is taken to use a solution of the colouring material prepared with the water which it is desired to examine.

The difficulties attendant upon the above procedure may be avoided by the following process, which has also the advantage that no foreign organisms are introduced. Place on the slide a drop of the *alcoholic solution* (1 : 1000) of the reagent, cyanine, B B B B B violet, gentian violet, dahlia, Bismarck brown, &c. Spread out the liquid with a glass rod and let it evaporate. When the evaporation is complete, or nearly complete, add a drop of the water (fresh or salt) intended to be studied and put on the cover-glass. Almost immediately, if the dose has been well calculated, the phenomena of paralysis and of colouring of the Infusoria may be observed.

In this way the author has coloured several species of *Vorticellæ*, *Paramecia*, *Amœbæ*, *Polytoma uvella* (flagellate) and Bacteria.

Mounting Histological Preparations with Carbolic Acid and Balsam.†—Mr. G. E. Fell transfers the prepared sections from the alcoholic preservative fluid to a clean slip and pours strong carbolic acid over the object immediately, allowing it to run off at one corner of the slide into a suitable receptacle. A thin cover-glass previously prepared with Canada balsam is then quickly applied, the balsam replacing the carbolic acid which, owing to its short contact with the tissue of the preparation, does not produce in it any appreciable shrinkage while still acting as a clearing agent. Pouring the alcohol over the preparation on the slide (followed by the carbolic acid) and allowing it to run off again, removes the extraneous filaments, bits of dust, &c., from about the specimen.

Dr. R. G. Mohr ‡ considers, however, that it is scarcely worth while to experiment with carbolic acid for histological mounts, as Seiler's method of mounting in alcohol balsam is so simple and perfect as to leave nothing more to be desired.

Differentiating Motor and Sensory Nerves.§—By the method adopted by L. Löwe and entitled "Method for obtaining preparations which demonstrate the structural difference between motor and sensory nerves, and are hence adapted for enabling the course of the fibres of the peripheral system of nerves to be traced," a fœtal rabbit, 3 to 4 centimetres in length, taken from the mother during life,

* Sep. repr. Bull. Soc. Zool. France, vi. (1881). See the author's previous papers, *ante*, pp. 279 and 280.

† Proc. Amer. Soc. Micr., 1881, p 87.

‡ Ibid., p. 88.

§ Zool. Anzeiger, iii. (1880) p. 503.

is placed for three months in not less than one litre of saturated solution of bichromate of potash, and the liquid changed twice; the bichromate is then carefully washed out with water, and the specimen finally stained entire in one litre of a weakly ammoniacal solution of carminate of ammonia, and may then be prepared for cutting sections by imbedding in gum-glycerine in the usual way. The motor nerves are darkly stained, and the sensory nerves faintly so.

Preparing Nerve-fibrils of the Brain.* —For making preparations to show the nerve-fibrils of the brain, J. Stilling calls renewed attention to Von Recklinghausen's method of macerating well-hardened specimens in wood-vinegar.

Cochineal Carmine-solution.†—J. Czokor grinds to a fine powder 7 grammes of cochineal (the same amount whatever quality is used) with as much burnt alum, and mixes it with 700 grammes distilled water and boils it down to 400 grammes. After cooling, a trace of carbolic acid solution is added and the whole filtered. From time to time a little carbolic acid solution must be added, and the solution filtered again. It stains substances prepared with alcohol or with chromic acid, the latter rather more slowly than the former. A solution made with a better quality of cochineal stains the nuclei the same colour as hæmatoxylin, the other tissues in various shades of red; if it is prepared with "Blut"-cochineal the intermediate tissue is less deeply coloured, the action resembling that of Grenacher's carmine.

Polarized Light as an Addition to Staining.‡—Mr. A. D. Michael, describing a plan of which he and Dr. J. Matthews are joint authors, suggests that polarized light might be of use as an addition to staining for vegetable and some animal substances, as it seemed to differentiate tissues somewhat in the same way. In practice it might be found to have its disadvantages, but it might have its advantages. No special preparation of the tissues was required, and the conditions were more natural than if they had undergone the process of bleaching and staining. It would also be possible, when they had a known selenite, always to repeat the same effect when required, whereas stained tissues frequently fade, and if there were any doubt as to the meaning of what was seen, the effects could be altered, and results secured that would be unattainable with the fixed effects of double staining. There was, of course, no difficulty in getting triple staining, or producing various colours, but the object which he showed was as if stained with a single colour only. [It was a section of *Serjanus* shown with oblique polarized light on a black ground.] He had heard some discussion as to the best means of obtaining polarized light on a black ground, and had heard it suggested that the results depended entirely on the object, that it was to be obtained only now and then

* Arch. Mikr. Anat., xviii. (1880) p. 468.

† Arch. Mikr. Anat., xviii. (1880) pp. 412–14. Cf. Zool. Jahresber. Neapel for 1880, i. p. 42.

‡ Journ. Quek. Micr. Club, i. (1882) pp. 49–51.

in the case of certain objects which had a capacity for it, also that it depended on the size of the polarizing prism and other causes. No doubt these did affect it to some extent, but he was of opinion that the effect was largely a question of what the object was mounted in. He did not find that Canada balsam was the best medium; in fact, the best effects were obtained by mounting in glycerine, when there was very little difficulty in making out the details, and the object looked brighter upon a blacker ground as contrasted with its appearance when mounted in balsam. He thought the idea would be found worth attention, especially where it was desirable to examine objects under various conditions of direct and oblique light.

Mr. T. C. White, in the discussion which followed, said that he had always found a good deal of difficulty in using polarized light on objects mounted in glycerine; while Dr. Matthews, on the point of the superiority of glycerine over balsam for the kind of examination in question, described his experience as rather the reverse of Mr. Michael's. Whether this arose from any difference in the objects he could not say, but he thought the effect was probably due to some difference in their density; the only way of settling the point would be to mount the same objects in both ways. He also thought that with extremely oblique light, they got fringes of colour—probably owing to diffraction. Mr. Michael had been very successful in getting dark-ground illumination, but there appeared to be some curious effect produced by a spot lens, less colour being produced in that way than without, although it might be supposed that the contrary would be the case. As to the differentiation of tissues, precisely the same effects were obtained as by staining, but with the advantage that a harmonious appearance was always produced, whereas with staining the selective power caused differences of colour which were not always harmonious.

Wickersheimer's Preservative Liquid.*—To the wet and dry methods of preserving with this liquid G. Brösike adds a third, the "damp" method. The subject is injected with the liquid, and the separate parts are moistened with it during dissection, and then enclosed in an air-tight vessel. The method is suited to nerves, tendons, fasciæ, vessels, and ligaments; muscles become bleached under its action. It appears to have no real advantages over a proper treatment with spirit, and the fact of the liquid containing poison must be borne in mind.

Brösike takes this occasion to correct an important printer's error in the official patent.† Instead of 10 grammes of arsenious acid it should be 20 grammes.

Preparing Hæmoglobin Crystals.‡—By using pyrogallic acid, C. Wedl has prepared for studying with the Microscope, spectroscope, and polariscope, hæmoglobin crystals from the blood of man, other mammals, and frogs. The best plan is to remove the colouring

* Centralbl. f. med. Wiss., ii. (1880) pp. 17–19. Cf. Jahresber. Anat. Physiol., ix. (1880) p. 82.

† See this Journal, iii. (1880) pp. 325–6.

‡ Virchow's Archiv, lxxx. (1880) p. 172. Cf. Zool. Jahresber. Neapel for 1880, i. p. 57.

matter from the corpuscles by the action of water, and to place some of the solution of hæmoglobin thus obtained, under a cover-glass (which should be raised at one side by a slip of glass laid beneath it) adding some pyrogallic acid. Frog's blood, the colouring matter of which is very difficult to extract, must remain in a moist chamber for several days before the acid is applied; the crystals then appear within the corpuscles. (Kölliker has seen them similarly in the red corpuscles of *Perea fluviatilis.*) It usually requires several hours' treatment to produce the crystals; they will keep for some time in the fluid.

Preserving Flowers.*—For preserving the colours of parts of flowers which it is desired to mount for the Microscope, Mr. G. Stocker finds a saturated solution of the ordinary potash alum crystallized ($Al_2\ 3SO_4$, $K_2\ SO_4$, $24\ H_2O$) most excellent. The objects should remain in the liquid for ten minutes or so, and then be dried between bibulous paper, placed in turpentine to render them transparent, and mounted in balsam. A portion of the vexillum of *Ulex Europæus* so mounted is without any of that reddishness which accompanies specimens mounted in the ordinary way; and a stigma of *Crocus sativus* is as full of colour as in its original state.

Cleaning Diatoms.†—Mr. K. M. Cunningham makes the following suggestion for cleaning diatomaceous material when largely contaminated with sand. "A quantity of the material is placed in a teaspoon, and water is then added until the teaspoon is nearly filled; the spoon is gently shaken with a back and forth or a circular motion, for a few seconds or longer, when the water must be quickly drawn off by applying the tip of a finger to the point of the spoon, taking care to draw off the superficial water, without allowing the heavier sediment to pass over the point. Pour from the spoon into a watch-glass, the surplus water is then drained off, and the diatoms removed for mounting. This method produces a magical concentration of the diatoms, large and small, making the remaining sand inconspicuous by the superabundance of the diatoms."

Gaule's Method of Imbedding.‡—The following method of imbedding was worked out by Dr. J. Gaule, by whom it was communicated to Professor E. A. Birge, who, having tried it on all sorts of tissue, can fully recommend it.

"A piece of tissue of convenient size is to be taken, treated with the ordinary reagents, and stained in the mass. If large it may be convenient to remove it from the staining fluid to alcohol for a few hours and then replace it. When thoroughly stained, the specimen is to be put in 70 per cent. alcohol for about twelve hours, then transferred to absolute alcohol until it is completely dehydrated. Then put it in oil of cloves overnight, or leave it there until it is convenient to imbed it. Place it in turpentine half an hour—large

* Sci.-Gossip, 1882, pp. 65–6.
† Amer. Mon. Micr. Journ., iii. (1882) p. 14.
‡ Ibid., pp. 73–5.

specimens for a longer time—then transfer it to a mixture of turpentine and paraffin, kept melted on a water-bath at about 40° C. In this the specimen, if from liver or intestine, &c., should remain for an hour or more; small nerves and blood-vessels of course need not remain so long. Then transfer it to a bath of pure paraffin, melted at a temperature of 60° C., and leave it for the same length of time. Indeed, if care be taken that the temperature does not materially exceed 60°, the specimen may remain as long as convenient. When the tissue is thoroughly saturated with melted paraffin, a small paper box may be filled with melted paraffin and the specimen placed in it to cool. If properly imbedded, a cut surface has a smooth and shining appearance. No line of division must appear between the specimen and surrounding paraffin. The whole mass should cut, as nearly as possible, like one homogeneous mass of paraffin.

The subsequent handling of the sections varies with their nature. Moderately thick sections of firm tissue may be placed in turpentine to remove the paraffin and mounted as usual in chloroform-balsam. Thin specimens, or those which come to pieces when the paraffin is removed, like thin sections of liver, &c., may be laid on the slide on which they are to be mounted, and the paraffin washed out by benzine, carefully applied by a dropping-tube; allow the benzine to evaporate, then lay on the cover-glass and apply thin chloroform-balsam at the edge of the cover. For exceedingly delicate specimens, such as embryos or osmic acid nerves, another method may be used. Lay the section on the slide, wet with absolute alcohol, and let the alcohol completely evaporate, leaving the specimen attached to the slide; carefully heat until the paraffin is softened or slightly melted. When cool, let a few drops of benzine—best applied with a brush—run over the section until most of the paraffin is gone. When dry, apply the cover-glass and put a thin solution of Canada-balsam in xylol to its edge. The xylol may be used instead of benzine, but it is more expensive.

This method is very convenient, especially for histological laboratories. The specimen once imbedded can be kept for years, and new sections cut as wanted. No change takes place in it, nor can it dry up. It is suited to all tissues. I have imbedded all vertebrate soft tissues, chick and trout embryos, hydras, snails, angle worms, clams, star-fishes, &c., with equal success in every case. The ease with which the sections can be made fully compensates for the time required to imbed. The merest tyro, provided with a good section-cutter, a brush to keep the sections from rolling, and such a specimen, must be a bungler indeed if he cannot cut at least thirty even sections from each millimetre of a moderate-sized specimen such as the œsophagus of a rabbit. With a little practice he should be able to cut a millimetre into one hundred sections without losing more than two. The writer has cut a frog's spinal cord so imbedded into 926 sections $\frac{1}{50}$ mm. thick in one day, and mounted them without losing any sections. No one who practises with these specimens will regard this as much of a feat; it is simply a

hard day's work. Specimens as large as the central hemisphere of a rabbit can be stained and imbedded whole.

I append my notes on the spinal cord of a frog, showing the times used in the various processes:—

Cord put into 3 per cent. nitric acid, 2 hours.

Seventy per cent. alcohol, 6 hours.

Stained in hæmatoxylin, 4 hours.

Seventy per cent. alcohol, overnight.

Ninety-five per cent. alcohol, 24 hours.

Oil of cloves, 24 hours (did not wish to imbed till next day); then,

Turpentine, stir half-an-hour.

Turpentine and paraffin, 1 hour.

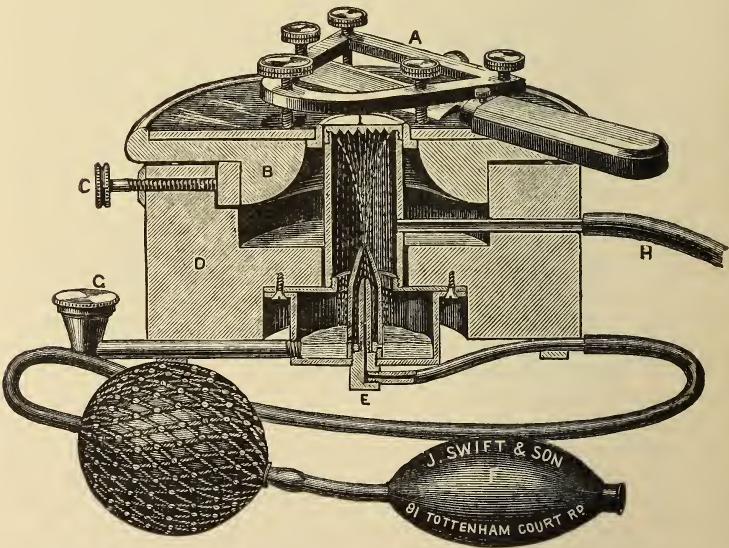
Paraffin, 1 hour.

It should be remembered that these cords imbed easily.

One caution further; select paraffin, if possible, which is bluish-transparent, and which rings slightly when struck. The white opaque sort is by no means as good. Any addition of paraffin-oil, turpentine, &c., to soften the paraffin, renders it granular and brittle, and is decidedly injurious to its cutting qualities."

Williams' Freezing Microtome adapted for Use with Ether.*— The original form of this Microtome was described and figured at pp. 697–9 of vol. i. (1881). It subsequently occurred to Mr. J. W.

Fig. 83.



Groves that it would be an improvement if it were adapted for the use of ether as a freezing agent instead of ice and salt. Mr. J. Swift

* Journ. Quek. Micr. Club, vi. (1881) pp. 293–5 (2 figs.).

accordingly worked out the details of the adaptation which is shown in Fig. 83. D represents the wooden bowl of the original form altered to hold the ether freezing apparatus. A and B are the razor frame and bowl-cover with the glass-plate top upon which the former is moved. The central brass cylinder, instead of being solid, is hollow, so that the ether spray may play up the inside and impinge upon the lower surface of the brass-plate I, upon the upper surface of which the material to be frozen is placed. In the figure, the hollowed cylinder is seen to open below into the ether-containing chamber, into the lower part of which also opens a horizontal tube, which turns up at right angles and ends in a funnel-shaped extremity G, over which screws a cap.

In the centre of the bottom of this chamber is a circular aperture closed by a piece of brass tubing, which passes up vertically to end in a cone with a very small aperture, and having another small hole in it towards the bottom. The lower end of this tube is plugged, and through the plug E passes vertically a very fine tube, which is continuous below with the tube from the apparatus for pumping in air. This consists of an indiarubber pump F, connected by a short piece of tubing with a slightly distensible ball covered with netting, and from the opposite side of which a piece of indiarubber tubing passes on towards E. In the side of the large hollow cylinder of the machine is inserted a small tube connected with a length of pipe H for the escape of the spray after use.

The method of freezing is as follows:—After the material has been partially hardened, and the hardening agent removed, place it on the brass plate I with a little gum mucilage;* then unscrew the cap G, fill the chamber with ether, replace the cap, and commence pumping by pressing the ball F vigorously and rapidly in the palm of the hand. Air will thus be pumped into the net-covered ball, from which it will issue in a continuous jet along the indiarubber tube, up the small tube, through the plug E, and again through the hole at the apex of the conical-ended vertical tube, to pass straight up against the under surface of the plate I. The rush of air thus produced causes pressure on the surface of the ether, and also tends to produce suction at the space between the small central tube and the one which has the conical extremity, so that the ether passes through the hole in the side of the latter tube, rises in the space between the two tubes, and is forced as a jet of spray through the hole in the cone, and so on to the under surface of the plate I. This is roughened in the form of teeth for the purpose of presenting a large area to be acted upon, and also to facilitate drainage. A great deal of the ether drops down into the chamber, and is used again, but a little passes out mingled with the air in such a finely atomized condition that it seems impossible to collect it, and it is therefore conveyed along the tube H to the external air.

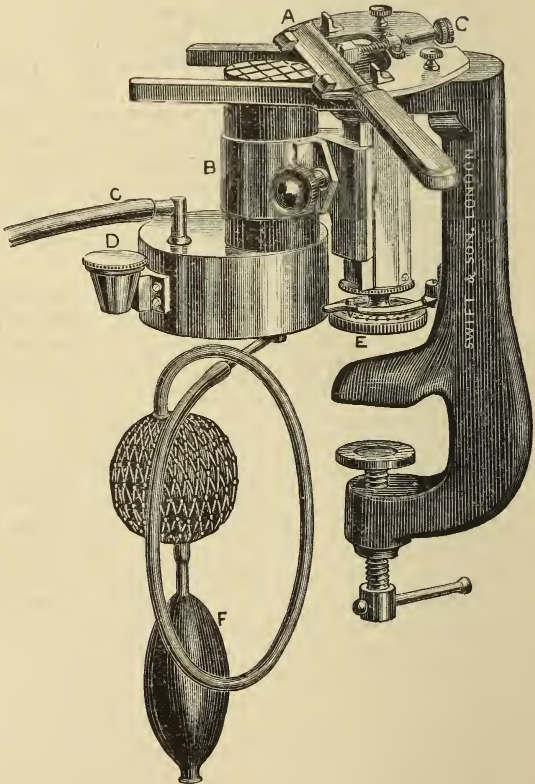
The advantages of the new form are that all mess with ice and salt is avoided, that ether can always be kept at hand, and that inhalation of the vapour is limited to the short period during which

* If the material is quite fresh the mucilage may be dispensed with.

the chamber is being filled. The labour of pumping may be reduced by placing the ball-pump between two pieces of wood hinged like lemon-squeezers. Material has been frozen in a room at 96 F. using ether of ·730 sp. gr.

Swift and Son's Improved Microtome.—In the microtome just described the sections are cut and their thickness regulated by the gradual descent of the knife towards the tissue to be operated upon. In order to reverse this process and provide a machine in which the tissue shall ascend towards the knife—as is the case in the ordinary form of section-cutters—Messrs. Swift and Son have brought out their new microtome, a drawing of which is given in Fig. 84, and which

Fig. 84.



is described as follows by Dr. S. Marsh in the new edition of his useful little work on section-cutting.

"The instrument consists of a massive iron upright, terminating at its lower extremity in a clamping arrangement, by which it may be securely fastened to the table. From the top of the upright two highly polished iron bars, lying parallel to each other, run horizontally for-

wards. These bars correspond to the cutting plate in the usual form of microtome, and upon them, as will be seen at A in the drawing, a flat brass frame carrying a knife is made to glide. The knife is kept firmly in position on this framework by means of the binding screw C, the end of which, terminating in a square clamp, presses against the back of the blade. The face of this clamp is grooved in different directions in such a manner that, according as the back of the blade is received into one or another of these grooves it is pushed from or drawn towards the level of the framework, thus affording a means by which the edge of the knife may be set at varying angles to the tissue to be cut. In front of the iron stand will be seen an angular upright pillar carrying in front of it a short length of sprung brass tube B, into which any of the apparatus presently to be described may be firmly fixed by a clamping screw. By means of a micrometer-screw E fixed at the base of the angular pillar, the sprung tube, and of course whatever it may carry, can be acted upon so as to raise or lower it at pleasure. The amount of movement thus effected is registered by the milled head of the screw, for which purpose three concentric circles have been drawn upon its face, each of which is so graduated that, as the face rotates from mark to mark, the distance traversed by the screw, and which of course determines the thickness of the section, will in the case of the outer circle be 1000th, in that of the middle 500th, and in the inner one 400th of an inch. The index by which these measurements are recorded consists of a spring catch so fitted that, as the milled head rotates, it drops into the divisions of the circles, into either of which it can be shifted at pleasure, or if desired can be thrown out of gear altogether. When it is intended to use the microtome for freezing with ether, the chamber provided for that purpose, and which in the engraving is shown in position, must be employed. This chamber is like the one already described when speaking of the Groves-Williams microtome, and consists of a reservoir for containing the ether and an upright cylinder leading from it, and terminating in a flat plate, upon which the object to be frozen lies. To use the machine, remove the cup D, fill the chamber with ether, then fix the cylinder in the clamp B, when the bellows F being worked the ether will project through the tubes in the interior of the chamber (which were described at p. 431), upon the plate holding the tissue, with the effect of speedily freezing it. When, under the action of the micrometer-screw, the object to be cut has moved upwards between the cutting bars sufficiently high for the purpose, sections are to be obtained by simply pushing the frame carrying the knife obliquely across the bars and through the tissue. For freezing purposes common methylated ether of a density of ·720 answers perfectly well. In winter when ice is plentiful, and where only a very small piece of tissue requires to be frozen, the freezing may be effected without the employment of ether. For this purpose it will be necessary to use Dr. Pritchard's solid freezer, Fig. 85. As will be seen, it consists of a solid metal block, having its upper surface, upon which the tissue to be frozen lies, roughened so as to prevent the specimen from slipping during section. For

use, the block and tissue are frozen by being immersed in powdered ice and salt, then the block is secured in the clamp B, and sections cut in the manner just described. The microtome, though essentially a freezing one, may however be employed for cutting objects imbedded in paraffin. For carrying out this, the box shown in Fig. 86 has been provided. The tissue is to be imbedded in this box, and when the paraffin has become quite cold, the box must be secured in the clamp B and the tissue sectionized.

"Yet another piece of apparatus belongs to this machine. It is called an adjustable vice, and is shown in Fig. 87. It is the most useful accessory, and there has long been a want felt for something

Fig. 85.

Fig. 86.

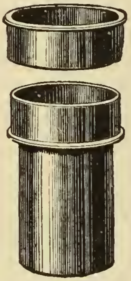
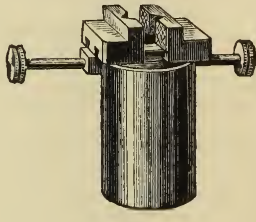


Fig. 87.



of its kind. It consists of a cylinder carrying at its upper end the two jaws of a vice. One of the jaws is fixed, whilst the other, being movable, may be made to recede from or approach to its fellow by means of the screw, so that hard substances of different kinds and various sizes may be securely fixed and held between the jaws, when, the cylinder being inserted in the clamp B, sections may be readily obtained. To the really working microscopist, this little appliance will be found of infinite value in a thousand directions. The uses of it are so obvious that no words will be wasted in describing them."

Though in this form, as in the others, the section knife, when in use, is mounted on a frame, no absolute necessity for its adoption exists, for the construction of the microtome permits of the use of an unmounted knife as readily as one mounted on a frame. The frame arranged has some advantages, particularly in retaining the keenness of the blade for a considerable period (coming into contact with nothing but the tissue) and in the confidence which it gives to the inexperienced operator. On the other hand, it renders the disengagement of the sections from the knife both a tedious and unsafe process, and Dr. Marsh is strongly of opinion, as the result of a very considerable amount of practical work, that in the hands of those who by careful practice have taught themselves how to use it, a simple unguarded knife is to be preferred to any mechanical arrangement whatever.

Bausch and Lomb's Standard Self-Centering Turntable.—We were unable to give at p. 284 any description of this turntable, but the following has since been supplied by Mr. E. Bausch.

The self-centering arrangement of the turntable is easily manipulated. The jaws are compressed by springs, and bear gently against the slide, so that, although it is firmly held, there is no danger of mutilating its corners or breaking it. One-sixth of a revolution of the milled ring is sufficient to open the jaws to their full extent, and as this is easily done with one hand, the other is free to place the slides. The hand-rest is detachable from the turntable. It has on its lower surface an adjusting screw for varying the distance from the revolving disk.

For refinishing old slides, or others on which the object has not been well centered, a detachable pair of spring clips are provided. Concentric circles up to one inch diameter are turned on the disk.

Crystallised Fruit Salt.*—Mr. G. J. Wightman says that Eno's fruit salt, when crystallised, makes a magnificent polariscope object. The mode of preparation is as follows: In a small test tube, say $3 \times \frac{5}{8}$ inches, dissolve as much of the salt as would rest on a sixpence, by adding distilled water to the depth of an inch. With the end of a glass rod spread a few drops over an ordinary glass slip, and in a few minutes crystallisation will take place. The slide (with selenite) will be seen to be covered with numerous beautiful formations, each somewhat resembling a Maltese cross made up of brilliantly-coloured needle-like crystals. If it is held over the flame of a lamp as soon as the solution is placed on (so as to hasten crystallisation), the colours will be the more splendid without selenite. Other beautiful effects may be produced by the addition of a few drops of alcohol to the test tube. The slides, as soon as dry, may be mounted in Canada balsam.

Allen, F. J.—Cleaning Gizzards.
[Feed the insects on honey, syrup, or treacle, before killing them.]
Journ. Post. Micr. Soc., I. (1882) pp. 48–9.

Arnold, J. W. S.—Microscopical Laboratories.
[Comments, &c., on the previous articles on the same subject—also as to the superiority of small instruments.]
Amer. Mon. Micr. Journ., III. (1882) pp. 69-70, 75.

Basevi, Col.—Mounting Starches.
[Not in balsam, but dry or in glycerine jelly, and viewed as opaque objects.]
Journ. Post. Micr. Soc., I. (1882) pp. 49–50.

Birge, E. A.—On a Convenient Method of Imbedding.
[*Supra*, p. 428.]
Amer. Mon. Micr. Journ., III. (1882) pp. 73–5.

Blood Stains on Steel.
[Dr. M. C. White recognized and measured by means of the vertical illuminator and $\frac{1}{8}$-inch objective, blood-corpuscles upon a steel instrument that had been exposed during two winters in the woods.]
Amer. Natural., XVI. (1882) p. 347.

Bowman, F. H.—See Cotton *infra*.

Chalon, Listes de préparations histologiques et botaniques de M. (List of histological and botanical preparations of M. Chalon.)
Bull. Soc. Belg. Micr., VII. (1882) pp. liv.–vii.

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* Sci.-Gossip, 1882, p. 64.

Cheeseman, E. L.—Home-made Apparatus for Collecting.
[Bottle-holder to be attached to a stick made of a narrow strip of sheet brass, and an ordinary gimlet-pointed wood-screw with the head flattened.]
Amer. Mon. Micr. Journ., III. (1882) p. 61 (1 fig.).

Coal-sections, Cutting.
[Notes by A. Smith, E. Holmes, and W. D. Smith, on Mr. Kitton's note *infra*—agreeing as to the failure of the carbonate of potash process.]
Sci.-Gossip, 1882, pp. 113–4.

Cotton Fibre, Structure of.
[Review of Dr. F. H. Bowman's book, *ante*, p. 119, with additional remarks.]
Amer. Natural., XVI. (1882) pp. 431–2.

Dyck, F. C. van.—Apparent Motions of Objects.
Amer. Mon. Micr. Journ., III. (1882) pp. 72–3.

Elcock, C.—How to Prepare Foraminifera.
[For recent Foraminifera *from sand,* such as shore-gatherings, dredgings, &c.—1. Well wash in fresh water to remove the salt. 2. Dry *perfectly,* and allow to get cold. 3. Sift (sieve No. 50 or 60). 4. Float the fine material in cold fresh water. 5. Dry the floatings. Perhaps it may also be found needful to—6. Boil the floatings in *liquor-potassæ*, B. P. 7. *Wash away every trace of potash.* 8. Dry. 9. Re-float in a beaker. 10. Dry again ready for mounting.]
Journ. Post. Micr. Soc., I. (1882) pp. 25–9.

Enock, F.—Metal Caps for Glycerine Mounts.
Journ. Quek. Micr. Club, I. (1881) p. 40.

Fleming, J.—Mounting *Volvox Globator* in Glycerine Jelly.
[After a month's time the *Volvox* mounted in glycerine jelly, boiling, &c. in the usual way, "is perfect in form and colour, and the success of the attempt goes to prove that this Alga can be treated like any other, and may be boiled and pressed without the destruction of its shape."]
North. Microscopist, II. (1882) p. 129.

Gottschau, —.—Mikrotomklammer für Keil- und plan-parallele Schnitte. (Microtome-clamp for wedge-shaped and plane sections.)
SB. Phys.-Med. Gesell. Würzburg, 1881, pp. 123–5.

Graff, T. S. U. de.—Resolution of Fasoldt's 18-band plate, and last band of 19-band plate.
[*Supra*, p. 416.]
Bausch & Lomb Optical Co.'s Supplement to Catalogue, Feb. 1882, p. 6.

Green, J. H.—Cleaning and Mounting Gizzards.
[Kill the insect in spirit and leave for 3 or 4 weeks to harden. On opening the gizzard the loose particles of food or dirt can be washed out by Mr. Nicholson's (*infra*) or other plans.—Mount in slightly acidulated glycerine (not balsam) in a cell of gold-size.]
Journ. Post. Micr. Soc., I. (1882) p. 49.

Groves, J. W.—Improved Ether Freezing Microtome.
[*Supra*, p. 432.]
Journ. Quek. Micr. Club, I. (1882) pp. 43–4.
Marsh's Microscopical Section-cutting, 2nd ed. 1882, pp. 60–8 (1 fig.).

Hatch, H.—Microscopical Laboratories.
[Remarks on article by Dr. J. W. Crumbaugh, *ante*, p. 287, who, he considers, desires to surround the student with too much and too expensive paraphernalia, discouraging him at the start.]
Amer. Mon. Micr. Journ., III. (1882) pp. 51–2.

Hitchcock, R.—Ruled Bands.
[*Supra*, p. 415.]
Amer. Mon. Micr. Journ., III. (1882) pp. 52–3.

" " Illumination and Resolution.
[Directions for resolving *Amphipleura pellucida*—in many cases of failure the fault is entirely in the illumination.]
Amer. Mon. Micr. Journ., III. (1882) pp. 53–4.

Hitchcock, R.—Mounting.

[General remarks as to mounting for "busy professional men who value every moment of their time and who, not having learned any simple process for mounting, are discouraged from attempting it by the multiplicity of processes and cements given in the books."]

Amer. Mon. Micr. Journ., III. (1882) pp. 55–6.

„ „ Collecting.

[Note on objects to be found in March–May, and suggestions for the novice in collecting.]

Amer. Mon. Micr. Journ., III. (1882) p. 77.

Jijema, J.—On the Origin and Growth of the Eggs and Egg-strings in *Nephelis*, with some observations on the "Spiral Asters."]

[Contains methods of investigation for (1) genital organs in fresh condition, (2) sections of entire leech, (3) hardening ovaries and egg-strings, (4) section-cutting, (5) surface views of the ovary-wall, (6) examination of early changes in mature eggs.]

Quart. Journ. Micr. Sci., XXII. (1882) pp. 189–211 (4 pls.).

Kitton, F.—Cutting Sections of Coal.

[Describes his failures with the process given under "Coal" in the 'Micrographic Dictionary' (maceration in carbonate of potash), and inquiring for the experience of others.]

Sci.-Gossip, 1882, p. 89.

Korschelt, E.—Eine neue Methode zur Conservirung von Infusorien und Amœben. (A New Method for Preserving Infusoria and Amœbæ.)

Zool. Anzeig., V. (1882) pp. 217–9.

Kunz, —.—Cinnamon Oil for the Examination of Rough Minerals.

[By applying a few drops of oil to the surface of a transparent mineral, the interior can be examined for inclusions, flaws, &c., without grinding the surface flat. Sand can thus be examined for inclusions under the Microscope.]

Amer. Mon. Micr. Journ., III. (1882) p. 59.

Lisle, T.—Glycerine-jelly Mounts.

[Remedy for failures caused by imperfect removal of superfluous jelly:—Apply a mixture of whiting or chalk and water about the consistency of cream, to absorb the jelly; dry and break off carefully.]

Journ. Post. Micr. Soc., I. (1882) p. 49.

Marchal, E.—Préparations microscopiques destinées à l'enseignement. (Microscopical Preparations for Teaching)—*contd.*

[B. Compound Organs, Stems, Roots, Leaves, Flowers; C. Cryptogams—Ferns, Mosses, Lichens, Algæ, Fungi.]

Bull. Soc. Belg. Micr., VII. (1882) pp. xlvi.–liv.

Marsh, S.—Microscopical Section-cutting. A practical Guide to the preparation and mounting of sections for the Microscope, special prominence being given to the subject of animal sections. 2nd ed. 8vo, London, 1882, xi. and 156 pp. and 17 figs.

Matthews, J.—*See* Michael, A. D.

Michael, A. D., and Matthews, J.—Polarized Light as an addition to Staining for Vegetable and Animal Substances.

[*Supra*, p. 426.]

Journ. Queck. Micr. Club, I. (1882) pp. 49–51.

Nicholson, A.—Cleaning Gizzards.

[Open and place in water for a day or two, and clean by agitating the water strongly by blowing through a pipette.]

Journ. Post. Micr. Soc., I. (1882) p. 49.

Nobert's Ruling Machine.

[A query as to its construction, &c., by Akakia.]

Engl. Mech., XXXV. (1882) p. 227.

Nordlinger's Wood Sections.

[Transverse sections of the most important and most common trees.]

North. Microscopist, II. (1882) p. 130.

OLLARD, J. A.—Micro-Fungi.
[Short note as to mounting.]
Engl. Mech., XXXV. (1882) p. 201.

PFITZNER, W.—Nervenendigungen in Epithel (Nerve-endings in Epithelium).
[Contains description of methods, pp. 731–2.]
Morphol. Jahr., VII. (1882) pp. 726–45 (1 pl.).

Pigeon-post Films.
[Offer of gelatine films used for transmission of news by pigeon post during the siege of Paris.]
Amer. Natural., XVI. (1882) p. 347.

POCKLINGTON, H.—The use of Staining Fluids in Vegetable Microscopy.
[Résumé of various processes.]
Engl. Mech., XXXV. (1882) pp. 210–2.

SCHRÖDER'S Microtome for Cutting Sections of Diatoms, &c.
[A query as to its practical success, by Akakia.]
Engl. Mech., XXXV. (1882) p. 227.

Snow Crystals.
[Query by T. Pearson as to the best way to examine them, "as they melt even in a room where there is no fire.]
Sci.-Gossip, 1882, p. 114.

SORBY, H. C.—Preparation of Transparent Sections of Rocks and Minerals. (*In part.*)
[Account of the method he originally adopted for rock sections when "everything had to be learnt, and there were then none of the facilities you have now."]
North. Microscopist, II. (1882) pp. 101–6.

TEASDALE, W.—G. Chantrill's Method of keeping objects alive for many months.
[A number of zinc shelves kept under a bell-glass, the requisite supply of moisture being provided by a quantity of thick felt kept constantly saturated.]
Journ. Quek. Micr. Club, I. (1882) p. 41.

UNDERHILL, H. M. J.—Cleaning Gizzards.
[Soaking in potash for a day.]
Journ. Post. Micr. Soc., I. (1882) p. 48.

" " —Glycerine-Jelly Mounts.
[Washing superfluous jelly off with a tooth-brush under water is a simpler method than Lisle's (*supra*). Varnish must be applied within half an hour after cleaning or the jelly shrinks from the edge.]
Journ. Post. Micr. Soc., I. (1882) p. 49.

"VOLVOX."—Microscopy.
[Examining circulation of blood in a tadpole's tail. Take a hollow slide, or make a little trough by cementing four little strips of glass on a 3 × 1 slip so as to make a shallow cell. After placing the tadpole on its side in the cell and covering with water, drop a very small quantity of chloroform over its head. There is then "no pain to the tadpole nor risk of bruising it as when it is put under pressure, and should too much chloroform have been given it could not die in an easier way."]
Engl. Mech., XXXV. (1882) pp. 216–7.

WHITE, T. C.—On the Injection of Specimens for Microscopic Examination.
[Describes the process of making transparent injections of a small Mammal with cold injection fluid (Beale's blue fluid), mounting in weak glycerine and camphor-water, and not in balsam or dammar, which would show nothing beyond the injected vessels, all the substructure which bears an intimate relation to the vascular arrangement being obliterated. Criticism of Dr. Carpenter's recommendation of injections by professional mounters.]
Journ. Quek. Micr. Club, I. (1882) pp. 15–9.

WILTON'S (E. W.) Pond Life.
[Intended supply of living objects.]
Sci.-Gossip, 1882, p. 90.

PROCEEDINGS OF THE SOCIETY.

Meeting of 12th April, 1882, at King's College, Strand, W.C., The President (Professor P. Martin Duncan, F.R.S) in the Chair.

The Minutes of the Meeting of 8th March last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Loew, O., and Bokorny, T.—Die Chemische Kraftquelle im lebenden Protoplasma. viii. and 78 pp. (1 plate). 8vo, München, 1882	*Dr. O. Loew.*
Micrographic Dictionary. 4th ed. Parts 8, 9, and 10	*Mr. Van Voorst.*
Postal Microscopical Society—Journal, vol. i. No. 1	*The Society.*

Mr. M. M. Hartog (of Owens College) described some specimens which he exhibited. One of these was a living larva of *Apus cancriformis*, the largest of the water fleas, the specimen shown having been bred this spring from some mud received from Germany. The other exhibits were a series of sections of Entomostraca which had been prepared for histological study. The specimens were killed by adding a few drops of osmic acid to the water in which they were placed, and as soon as they fell to the bottom they were sometimes removed to spirit direct; this plan had its advantage inasmuch as any mutilation was thereby avoided, but on the other hand by opening them in the osmic acid a certain amount of maceration was avoidable, which might in the former case prove to be detrimental to the histological structure. They were first transferred to 30 per cent. spirit, and then to 50 per cent., after which they were placed in cochineal solution in 70 per cent. alcohol and washed repeatedly in clean 70 per cent. alcohol until they gave up no more colour. Afterwards they were placed in 90 per cent., and then in absolute alcohol. They were next treated after Giesbrecht's method, with a greasy medium, and for this purpose whilst they were in the absolute alcohol a small quantity of oil of cloves was poured in, this sank to the bottom of the tube, and the Entomostraca would then lie not at the bottom but just between the alcohol and the oil of cloves, which gradually replaces the alcohol. In this way, with specimens which had been unopened, he had obtained preparations in which there had been absolutely no shrinkage of the protoplasm. Most of the oil of cloves was poured away and the specimens having been imbedded in a mixture of spermaceti and castor oil, the sections were cut in the usual way. It would be noticed that the sections were arranged in series on the slide. By this means of preparation he had been able to make out some important points. The specimens exhibited

(sagittal sections) the entire organs of the body, the nervous cord could be well seen, as could also the gullet with its muscles. A rough sketch was made on the slate to illustrate the chief points of interest.

Mr. Beck thought the remarks of Mr. Hartog were exceedingly interesting, for if they were ever really to understand these structures it must be by means of sections. He was glad to have heard the very practical remarks which had been made, and hoped they would be the means of inducing others to practise the process, feeling sure that such a study would elucidate many points which were now involved in mystery.

Mr. Stewart inquired whether in cutting the sections a microtome was used, or whether they were cut by hand. It also occurred to him that this process might be very useful in the preparation of sections of many of the soft-bodied creatures such as the mites or the Arachnida, for it was very difficult to make out many parts of their anatomy by any process of dissection.

Mr. Hartog, in reply, said that in all cases where sections had to be cut in series a microtome was necessarily used in order to secure perfect regularity of thickness. Zeiss's microtome was the one he had employed, using oil to moisten the razor. He agreed that the process would be very useful in the case of mites and spiders, but he thought it well to remark that picric acid—so much in favour for some purposes—should be avoided, as it penetrated too freely and caused the soft tissues to shrink from the chitinous body-wall.

Mr. Crisp called attention to two Microscopes which he had brought for exhibition; one of these, made in Dundee—which it had been proposed to call the "Jumbo" Microscope—stood 4 feet high, with a tube 4 inches in diameter, and weighed about $1\frac{1}{2}$ cwt. It must have been made about 50 years ago. The other (the "Midget") made by Mr. S. Holmes—shown by way of contrast—was completely finished for use, its entire height being only 3 inches, and its weight only a few ounces. Six of such Microscopes could be enclosed in the eye-piece of the larger one. He also exhibited the "Acme" Class Microscope (see p. 251), and Browning's Portable Microscope (see p. 252).

Mr. Beck examined the large instrument and made some remarks as to the peculiarity of its construction.

Dr. Loew's note as to the chemical difference between living and dead protoplasm was read, and a photograph exhibited illustrating his and Bokorny's statement as to the different reaction of dead and living protoplasm on silver salts (see I. (1881) pp. 906–7).

Mr. A. W. Bennett said that the photograph represented two filaments of *Spirogyra nitida*. One of these had been subjected in a living condition to the silver reagent, and the reducing effect of the living protoplasm had converted the cell-contents into a black opaque mass. The other filament had been killed by a 1 per cent. solution of citric acid before treatment with the silver solution. In this case

no reduction and consequent blackening is exhibited, the spiral arrangement of the chlorophyll-bands being still perfectly distinct.

Mr. Stewart said he did not see that they had any actual proof that the protoplasm in the one case was dead and in the other living, especially when it was borne in mind that the way in which it was killed was by means of citric acid, a small residual quantity of which he thought might have some effect upon the result.

Mr. Bennett said it was clear that they wanted more particulars before coming to a definite conclusion, though it was naturally to be supposed that all acid had been removed before the tests were applied.

Mr. Hartog referred to the silver staining processes recently described in the Journal.

Mr. Stewart said if they wanted to make silver staining a test in the case of the tissues of living animals it would not always be found an easy thing to do. In cases of operations they could probably get living tissues, but there were many parts which it would be very desirable to test with, which could not be obtained until after twenty-four hours from time of death, and yet he thought that in such cases the outlines of a cell were as perfectly rendered as if they were living. He was afraid that unless the citric acid were entirely eliminated, it would probably exercise an important influence on the results.

Dr. Matthews felt sure that such would be the case, for it was well known that in photography the developing fluids had been acidified—and this especially by citric acid—for the purpose of retarding the reduction of the silver salt, so that the results where acid had been concerned would be very suspicious. The use of alkaline instead of acid preparations was the secret of the modern rapid processes of photographic development.

Mr. Crisp referred to the views of Prof. Grunow on W. Prinz's paper on Diatoms in Thin Rock Sections (see p. 246).

Mr. Ingpen read a note on the use of diaphragms, illustrating his remarks by drawings upon the black-board. The ordinary wheel of diaphragms in general use was, he considered, effective only to a certain extent; and he gave the preference very decidedly to the sliding cylinder-diaphragm so largely adopted on the Continent, which was in fact a modification of that devised many years ago by Varley, in which double cylinders were used, one working within the other. The outer one had a moderate-sized opening sliding up in the substage, or in the ring provided for the purpose beneath the stage, until in contact with the slide. This cylinder was lined with cloth, to facilitate the sliding of the second cylinder, having a similar opening in the cap. By the proper use of this double cylinder the cone of light could be modified in the most perfect manner,—in fact it left nothing to be desired. The plate of diaphragms devised by Dr. Anthony, consisting of a series of apertures in a strip of vellum, to be placed immediately beneath the slide upon the stage, did not appear to him effective, inasmuch as at the position in which it was

placed, the cone of rays was far too small to be affected by the size of apertures adopted, passing, in fact, completely within the apertures. He might apply the same remarks to the action of the *calotte* diaphragms, which he regarded as based on a wrong conception of the action of diaphragms. He could not commend the iris diaphragm on the ground that it required a special fitting, and could rarely be used near enough to the slide.

Mr. J. Mayall, jun., said there was another purpose in the application of diaphragms, not touched upon in Mr. Ingpen's remarks, namely, the cutting off different portions of the illuminating pencil. The mere cutting down the diameter was the main object of the wheel of apertures in common use, and of the cylinder diaphragms referred to, but Dr. Anthony's diaphragm was intended to supplement the action of the strictly central aperture by a series that could be easily applied to cut off more or less of the beam after all had been done that was possible in modifying the light with the central apertures,—to use a phrase of Dr. Anthony's, "to give the finishing touch to the illumination." Regarding the *calotte* diaphragm, its application, as a diaphragm alone, immediately beneath the slide, was due to Mr. Zeiss, who was hardly likely to have adopted it unless he had found it effective. The still more recent application of it *above* the condenser must be regarded as a step in advance. Mr. Bulloch, of Chicago, appeared to be one of the earliest to see that the diaphragms *beneath* the optical combination in Gillett's condenser, might be advantageously applied *above* the lenses, where the cone of rays is so short and of such great angular extension that every variation in size or shape in the apertures of the *calotte* would be effective. Mr. Swift had also adopted the *calotte* in connection with the achromatic condenser. The iris diaphragm was effective for low powers, especially when mounted to fit in the stage itself, as adopted by Messrs. Ross; but he had not been satisfied with it in connection with the achromatic condenser. He believed there were difficulties in the construction which rendered it almost impossible to close the aperture with sufficiently accurate centering to be of real service with the condenser. In conclusion, Mr. Mayall said that the great number of devices that had been brought forward in recent years to cut off portions of the illuminating pencil independently of the mere reduction of the cone by strictly central apertures, proved conclusively that a need was felt in that direction.

Mr. Beck said that though there might be differences of opinion as to what was the most valuable kind, he thought no one would dispute the great importance of a good diaphragm, which was of extreme value in rendering visible portions of an object which otherwise could not be seen.

Mr. Ingpen said that his remarks were merely taking things as they stood, and did not, of course, apply to the use of the *calotte* diaphragm with the achromatic condenser. The *calotte* diaphragm, as drawn by Mr. Mayall, was very effective, but almost every effect could be obtained by a very small number of stops with tolerably small apertures. Professor Abbe had satisfied himself of this entirely.

The President read a note on the histology of the Temnopleuridæ, which he illustrated by drawings upon the black-board.

Mr. Stewart called attention to a curious change which took place under certain circumstances in the reticulated network; where there was any friction going on it was found that the interstices became filled up with carbonate of lime, and this seemed to be a case of precisely the same kind as what went on in bone-tissues under similar circumstances. Besides the spicules in the hard tissues there was found a remarkable exception in the structure of the teeth, which more closely resembled silicious rather than calcareous spicules.

Mr. Hartog said that in studying the structure of these organisms it was important to study the soft parts in connection with the hard ones. To do this the specimen should be first stained and then saturated with liquid Canada balsam, which should be evaporated down to a resin: sections could then be cut through the shell and the soft parts, at the same time showing them together *in situ*, and stained as far as they could be.

Mr. Stewart said that in Koch's method it was solid copal varnish which was used instead of solid Canada balsam, the latter being too brittle to enable good sections to be cut. He had seen sections which had been made by this method, and they certainly showed the structure remarkably well in the corals, &c.

The President said that Koch's method was a most excellent one as applied to corals, but it did not answer so well for Echinoderms. He had found it a very good plan to dissolve out the calcareous portions with weak acid. With regard to the fossil forms they all knew that the reticulated structure was entirely lost during fossilization, when it seemed entirely filled up by calcite.

Mr. Stewart remarked that this complex network showed under the polariscope a common axis of tension passing through the entire body.

Professor Abbe's paper "On All-round Vision" was read by Mr. Crisp.

The following Instruments, Objects, &c., were exhibited:—

Mr. Crisp:—(1) "Jumbo" Microscope; (2) "Midget" Microscope; (3) "Acme" Class Microscope (see p. 251); (4) Browning's Portable Microscope (see p. 252).

Mr. Hartog:—*Apus cancriformis* and a series of sections of Entomostraca.

Mr. Ingpen:—Zeiss Microscope and sliding cylinder-diaphragms.

Dr. Loew:—Photographs of *Spirogyra nitida*.

Baron Ferd. v. Mueller, K.C.M.G., &c.:—Various dried Algæ from the Phytologic Museum of Melbourne.

Mr. L. A. Sillem:—Foot of Emerald spider.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. John A. Ollard, Henry Palmer, and Henry Pocklington. *Honorary* Fellows:—Professor C. Robin and Dr. L. Dippel.

Conversazione.

The Second Conversazione of the Session was held on the 26th April in the Libraries of King's College, when the following objects, &c., were exhibited:—

Mr. J. Badcock:
 Fredericella sultana and *Epistylis* sp.

Mr. C. Baker:
 Preparations from the Zoological Station, Naples.

Messrs. R. and J. Beck:
 Section of Leech and International Microscope.

Mr. Thos. Bolton:
 Fredericella sultana.

Mr. W. G. Cocks:
 Lacinularia socialis.

Mr. Crisp:
 Various Schizophytes mounted by Dr. Zimmermann, of Chemnitz.

Mr. H. Crouch:
 New Portable Microscope, and Siddall's stage for use with ordinary selenites.

Mr. Thos. Curties:
 Section of Triton, and larva of *Synapta.*

Mr. E. T. Draper:
 Portfolio of drawings of microscopical objects.

Mr. L. Dreyfus:
 Argulus foliaceus.

Mr. F. Enock:
 Heads of bees showing all the organs of the mouth in their natural form and colour. *Œdipoda cruceata*, one day old; born in England from eggs sent from Troy.

Mr. F. Fitch:
 Ventral cords of blow-fly from thoracic ganglion to end of abdomen and ramification.

Mr. C. J. Fox:
 Diffraction effects produced by rectilinear and circular gratings.

Dr. H. Gibbes:
 Human epididymis with spermatozoa in the tubes; section of mammalian kidney showing ciliated epithelium in the convoluted tubes, and cerebellum injected and treble stained, showing cells of Purkinge and nerves proceeding from them.

Mr. N. E. Green:
 Pleurosigma formosum by side and transmitted light, and Nottingham deposit by side light.

Mr. J. Hood:
 Cristatella mucedo.

Mr. Joshua:
 Ceramium acanthonopum showing tetraspores, and *Hydrurus pencillatus* sent from Norway by Dr. O. Nordstedt.

Mr. A. D. Michael:
 Pachygnatha de Geerii showing accessory sexual organs, and *Tenuipalpus spinosus.*

Dr. Millar:
Rectangular network of *Dendispongia Steerii.*

Mr. C. N. Peal:
Experiments illustrating the effect of various kinds of illumination upon the appearances of diatoms. Micro-photographs of diatoms by Mr. J. H. Jennings, of Nottingham.

Mr. B. W. Priest:
Arachnoidiscus japonicus in situ.

Mr. J. W. Reed:
Crystalloids in *Lathræa squamaria* and in the seed of *Ricinus communis.*

Mr. A. Sanders:
Stained sections of the brain of *Hyperopisus dorsalis*, a fish belonging to the family Mormyridæ.

Mr. Sigsworth:
Double platino-cyanide of magnesium and yttrium of various forms.

Mr. L. A. Sillem:
Volkeria pustulosa, plates of star-fish, &c.

Mr. George Smith:
Section of meteorite (U.S.A.).

Mr. James Smith:
Aphides of rose and nettle.

Mr. J. H. Steward:
Pleurosigma angulatum with $\frac{1}{20}$ immersion object-glass by Hensoldt, Meteorite showing fluid cavities, &c.

Mr. A. W. Stokes:
Combustion and volatilization of zinc, copper, iron, &c., in the electric arc under the Microscope.

Mr. H. J. Waddington:
Stephanoceros and *Melicerta.*

Mr. F. H. Ward:
Section of stems of *Jasminium nudiflorum* and *Ampelidea* double stained.

Mr. E. Wheeler:
Ruby and ruby sand section of meteorite showing cavities with liquid or gaseous contents; new Diatomaceæ from Hong Kong, &c.

Mr. T. C. White:
Rectal papillæ of blow-fly and earwig.

Messrs. J. Swift and Son:
Podura scale with student's $\frac{1}{8}$ object-glass on improved American Microscope.

MEETING OF 10TH MAY, 1882, AT KING'S COLLEGE, STRAND, W.C., JAMES GLAISHER, ESQ., F.R.S., IN THE CHAIR.

The Minutes of the Meeting of 12th April last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Blades, W.—The Enemies of Books. 3rd ed., 1881	*Prof. A. Liversidge, F.R.S.*
Geological and Natural History Survey of Canada. Report of Progress for 1879–80. (8vo, Montreal, 1881)..	*Government of the Dominion.*
Hermann, L.—Handbuch der Physiologie. Vol. iv. Part 2. viii. and 467 pp., 58 figs. (8vo, Leipzig, 1882)	*Mr. Crisp.*
Micrographic Dictionary, Part 11	*Mr. Van Voorst.*

Mr. Crisp read letters from Professor C. Robin and Dr. L. Dippel in acknowledgment of their election as Honorary Fellows.

Mr. Dowdeswell read a paper on "The Bacteria of Davaine's Septicæmia" (see p. 310).

The Chairman said he was very glad that they had had a paper on so important a subject. Observations upon *Bacteria* were daily acquiring more and more value, from their supposed connection with various kinds of disease. He hoped that Mr. Dowdeswell would continue his observations upon the subject, and that he would be able to explain the great discrepancies which he had observed to exist between the size of the specimens he had described and those which had been referred to by other observers.

The Chairman referred to a letter received from Mr. Ralph, the President of the Victoria (Australia) Microscopical Society, in which he mentioned that he expected to be present that evening. At the last moment, however, he had been prevented from coming. He was sure they would all hope that Mr. Ralph would be in England at their next meeting, so that they might welcome him both as one of their ex-officio Fellows and also as the representative of almost the only Colonial Microscopical Society.

Mr. Burnett's note on a new form of rotating live-box was read and the apparatus exhibited (see p. 410).

Mr. Sigsworth exhibited a spring paper-clip which he had found very useful in fastening card cells upon slides and much more convenient for the purpose than the so-called "American" clips.

Dr. Van Heurck's views on the use of the incandescent electric light for microscopy were briefly referred to by Mr. Crisp, who explained, by means of black-board drawings, two cases in which, in consequence of its superior intensity, the electric light might be made use of to extend somewhat the resolving power of an objective. Dr. Van Heurck had recently obtained an improved form of battery which superseded the one he originally described. He found the Swan form of lamp to be the most suitable for microscopical work (see p. 418).

Professor Abbe's paper "On the Relation of Aperture and Power in the Microscope," Part I. (see p. 300), was read by Mr. Crisp, who

referred to the complete paper as being one of the most valuable and useful papers that had ever been brought before the Society, dealing as it did not only with the theoretical part of the subject but establishing also a rational standard for the practical construction of objectives.

The Chairman considered that Professor Abbe's paper was indeed a most useful one, and that it would be greatly appreciated by practical opticians.

Mr. Beck said that he considered it was an exceedingly valuable paper, and one that would enlighten a great many persons as to the relative value of aperture and magnifying power in regard to which great confusion had existed. There were people who thought that if they could get a 1-inch objective with an aperture of 120°, they could resolve difficult diatom tests. He had heard it claimed that such glasses had been made, but although he had ordered one he had not yet been able to get it, and hopes that might have been raised by these announcements would be damped by the contents of Professor Abbe's paper. He was very glad that it had been written, because it had been his impression for some time that Professor Abbe had been working exclusively in the direction of wide apertures.

Mr. Ingpen was surprised to hear Professor Abbe, of all persons, charged with an exclusive approval of large apertures, for if any one looked at Zeiss's catalogue, they would see at once that all the dry lenses were of remarkably small angles, nothing exceeding 110°.

Mr. Crisp said that the most opposite notions had been held as to Professor Abbe's views on wide or narrow apertures. Some years ago it was stated, at one of the Society's meetings, that he advocated only narrow apertures, and some correspondence took place in regard to it in the 'Monthly Microscopical Journal.' Again, later, it was insisted that Professor Abbe considered all but wide powers useless to the microscopist! The fact was that Professor Abbe had, since the date of his earliest observations on aperture, advocated the maintenance of a proper ratio between aperture and power—wide apertures for high powers, and small apertures for low powers — and had always insisted on the great importance of perfecting the construction of moderate apertures. The confusion had arisen from the fact of Professor Abbe having shown, in connection with his theory of microscopical vision, that wide apertures, and wide apertures only, gave true images of *minute* objects; but it did not, of course, follow from that, that wide apertures were to be universally used, with low powers and with objects unsuitable, either from their requiring depth of vision or for other reasons.

Mr. J. Mayall, jun., exhibited Ross's "Hospital Microscope," the speciality of which is the fine adjustment, which is of simple construction.

Dr. Maddox read a paper "On Some Micro-organisms from Ice-Water and Hail," illustrated by a number of photo-micrographs.

The Chairman inquired how Dr. Maddox accounted for the exist-

ence of the organisms which he had described. Did they come from the atmosphere?

Dr. Maddox thought that with regard to those from the ice of the water-butt, they probably were in the rain-water before it froze, and they alone survived; those found in the water from melted hail most likely came down from the atmosphere with the hail.

Prof. F. J. Bell's paper, "Note on the Spicules found in the Ambulacral Tubes of the regular Echinoidea" (see p. 297), was, owing to the lateness of the hour, taken as read.

The following Instruments, Objects, &c., were exhibited:—

Mr. Burnett:—New form of Rotating Live-Box (see p. 410).

Mr. Dowdeswell:—*Bacteria* illustrating his paper (see p. 310).

Dr. Maddox:—Photo-micrographs illustrating his paper.

Mr. J. Mayall, jun.:—Ross's Hospital Microscope.

Mr. Sigsworth:—Spring clip.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. T. S. Up de Graff, M.D., John Inglis, J.P., Captain A. H. Southey, Prof. Ramsay Wright, and John Wright.

WALTER W. REEVES,
Assist.-Secretary.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST 1882.

TRANSACTIONS OF THE SOCIETY.

X.—*On some Micro-organisms from Rainwater-Ice, and Hail.*

By R. L. Maddox, M.D., Hon. F.R.M.S., &c.

(*Read 10th May*, 1882.)

The study of the minute organisms belonging to the Schizophytes is one of special interest, for they touch the final history of all living beings, and very possibly hasten, if they do not actually cause, premature death. The researches within late years by very able microscopists and members of the medical profession have been numerous, though far from exhaustive. They embrace almost every field of inquiry, as the valuable Summary in the pages of the Journal of the Society so well attests; hence, some one may have preceded me in similar observations, as ice, hail, snow, rain, and dew have each been often examined; I am not aware, however, that the points I have to mention have been specially noticed; and I therefore trust they may not be wholly devoid of interest, even in their incompleteness.

The winter of 1880–81 was of considerable severity from the extreme cold, which if already forgotten, allow me to recall to memory, by stating the fact that at my residence, one day whilst at dinner, with a good fire in the room, water when poured into a tumbler immediately became a mass of beautiful ice-crystals. The out-of-door temperature for several days was such, that the rain-water in the open garden rain-water butt was frozen to the depth of more than 12 inches. When the thaw occurred, I placed a large block of the ice, after *well draining*, in a clean new pan, and removed it into the house, set it in a fireless room, and covered it carefully from the dust. Three days later I noticed a thin scum extending over the entire surface of the water in the butt, and at once put some on a slide and examined it with the Microscope. It was found to be a mass of micro-organisms lying in a pellicle intermixed with particles of soot, dust, and a few minute oily-looking

globules. The organisms differed from any I have ever noticed before or seen figured in any papers treating on Bacteria. Slides were prepared, some without staining the objects, others by staining with aniline blue, and much later on were photographed, using a $\frac{1}{8}$-inch objective and artificial lamp-light. The exposure upon the (commercially so called) "instantaneous" gelatino-bromide plates varied from four to five minutes. The negatives, from deficiency in actinic power of the light employed, were too thin to furnish fair paper prints; hence they were copied upon wet collodion into positives, and these by the same procedure into denser negatives with some enlargement compared with the originals.

The micro-organisms in the pellicle, as seen under the Microscope, appeared as minute rods or joints very irregularly shaped, and most of them larger at one end than the other, being either club-shaped or like the handle of a pistol, possibly due to the formation of a spore at that end, though this is doubted by some, for many had lying upon or near to the thick end a round or oval body, as if it had escaped from the adjacent rod. Some of the little bodies tapered gradually from the thick end. Where the placing of the pellicle on the thin cover-glass had not much disturbed its condition, the organisms were seen to lie very generally side by side, though not evenly, and in more or less slightly curved lines, as if the growth had been in a longitudinal direction upon a gentle curve, yet not giving rise to the sharper curve seen in many of the rods forming the mass. Amongst the numerous figures given in the 'Annuaire de l'Observatoire de Montsouris,' for the last three years, by M. Miquel, of the various micro-organisms he has found in the air by daily systematic observation, I have not noticed one similar to the one described. Besides these organisms there were a few small bodies in the pellicle, looking like ordinary bacteria and micrococci; but the general mass in the scum consisted of the large forms. Their size varied considerably, the large ranging from the $\frac{1}{6000}$ to $\frac{1}{5000}$ of an inch, and the small of the same kind, to little more than half this length. Whether these bodies should be placed in the Schizophytes as Bacteria or Bacilli, I was doubtful, as more experienced observers than myself differed in opinion. No movement was seen in those freed from the broken edge of the pellicle. The difference in shape from the ordinary Bacilli rods might have been due to hindrance in their development from the previous severe cold, though if confirmed in future observations, it may be of a specific character.

The block of ice removed to the pan, furnished on the third day a pellicle which was much thinner, but contained exactly similar rods. There was considerably less contamination. The same was examined at different periods, and after remaining undisturbed for more than thirteen months showed the rods to differ but little from

the original ones; being rather straighter, the club or pistol-handle shape still very evident, and the rods in somewhat more regular position. From the result of my rough cultivation experiments I am inclined to regard them as Bacilli. A few cultivations were attempted with the pellicle from the water-butt, also from the pan. For instance, I tried to cultivate them in sterilized (i. e. by boiling) normal urine, in sterilized infusion of Liebig extract of meat, upon cold boiled potatoes and the white of hard-boiled egg, without increased temperature beyond that of a fireless room, but with no positive success. Yet eight months later a speck taken from the pellicle, removed with some of the water from the butt at the time of the original observation, carefully kept covered and undisturbed, and which contained the club-shaped rods in abundance, when placed on sterilized gelatine jelly prepared with infusion of Liebig extract of meat, showed ready growth in the rods, some to more than twice their original length, others multiplying into short joints. In the long ones the characteristic irregularity of outline was apparent in very many. The growth from two minute specks placed one at each end on a layer of the jelly, poured on a scrupulously clean slide, soon covered in length the intervening distance of an inch. Curiously, they were more or less arranged in circular groups, the centre being often occupied with a beautiful rosette of some salt crystal, though the individual rods were without regular arrangement, the short rods crossing each other in all directions. After such an interval it would be hazardous to say they were all derived from the club-shaped rods. What I wish to note is, that *they* grew into longer ones, so to establish their claim to be placed amongst the Bacilli. Later still, in the month of April this year, some of the same pellicle was sown on peptonized gelatine jelly without any evidence of the growth of the rods, and at the same date some placed on hard-boiled white of egg offered no change discernible, though in both cases there were very many minute organisms, as bacteria and micrococci, in Brownian movement. I may note that Mr. M. A. Veeder, U.S.A., found that various infusoria, confervæ, &c., in the sediment of the clearest parts of blocks of ice from stagnant water of ponds and canals, would revive when melted, and considers such ice doubtful for drinking purposes.

I will now pass to some remarks on the micro-organisms found in melted freshly-fallen hail.

A rather heavy hailstorm happening on the 25th of last March, I took the opportunity to collect some of the hail for examination while the storm continued, by dipping a perfectly clean tumbler into a drifted heap lodged in one corner of the window-ledge, without touching anything else; immediately covering the tumbler with a clean plate of glass, and allowing the hail

to melt in a room without a fire. On the second day a faint scum was visible on the surface in patches, enveloping grey, soot-like particles. Some of this pellicle seen under the Microscope showed very pale, motionless organisms lying in it, resembling rather elongated micrococci. The water was left further undisturbed for another day, but furnished no appreciable difference except greater distinctness of the imbedded organisms. Some of the pellicle was stained with aniline blue, and mounted in acetate of potash solution without having been dried. Whether from want of refractive differentiation between the objects and mounting medium, or from the acetate of potash acting upon the pellicle, the outlines of the minute organisms were indistinct; consequently a different method was adopted, which seemed to offer advantages. A speck of the pellicle was placed, with as little disturbance as possible, in a droplet of distilled water on the cover-glass, then, as recommended by different observers, dried over a flame, in this case very slowly. Afterwards it was covered with the following staining fluid and protected from the dust:—

Bismarck or aniline brown (of German make), 4 grains; citric acid, 16 grains; distilled water, 200 minims; boiled in a test-tube, cooled, filtered, reboiled, and a trace of carbolic acid added.

After being covered with the staining medium for an hour it was washed with distilled water by tipping off the fluid, draining closely on blotting-paper, repeating this until the water was colourless, then drying again by gentle heat and mounting the cover dry.

Previously I tried the aniline brown without the citric acid, but the addition of the latter appeared to facilitate the washing by increasing the solubility of the colouring agent without lessening the staining qualities.

Great care was required if the specimens were washed with the cover on the slide, for the least displacement caused the pellicle with its organisms to roll up into continuous lines.

I am not prepared to say that the method of drying does not slightly shrink the objects. I fear it does, though I do not think more than osmic acid, as the substance enveloping the organisms appears indistinctly afterwards. The minute bodies found in the melted hail differed most completely from those of the frozen rain-water. In parts where but little disturbance of the pellicle occurred upon removal for examination, the organisms were seen lying very irregularly near to each other, whilst in what appeared to be a *second* pellicle formed just beneath the outer one, they occurred mostly in rows, and are often at rather an acute angle with one another. In size they differed, doubtless owing to being in various stages of growth and fission.

The average size is from the $\frac{1}{21000}$ to the $\frac{1}{18000}$ of an inch in length; some looked round, others like elongated micrococci, and when fission was about to occur very like ordinary bacteria. As they were when free motionless, I felt inclined to suppose them to be micrococci, but from some cultivation experiments I believe they must be termed bacteria.

Thus a speck of the pellicle was placed on freshly boiled white of egg, and kept carefully covered and turned down without touching anything except by the broken shell edge. The second day, about thirty-six hours after the inoculation, on removing a minute portion and diluting it with distilled water, it presented an incredible crowd of bacteria in rapid motion, resembling closely, if not actually, *Bacterium termo.* On the sixth day the white of egg, at the spot of inoculation and for some distance beyond, presented a beautiful pale canary-yellow colour, and on the eleventh day a bright deep rose-coloured spot also appeared, very closely to the seat of puncture, consisting of motionless micrococci. This has been successfully cultivated through several generations on the same medium.

A portion of the original pellicle placed on peptonized gelatine jelly on the thin cover, and this placed over a tin cell cemented to an ordinary slide, the surface of the tin circle being smeared with vaseline (as recommended, I believe, by an American microscopist), except at two small opposite points, and then kept at the temperature of about 58° F., had on the second day so softened the gelatine by the changes induced in it, that the spot of inoculation was quite fluid, teeming with minute organisms in most rapid motion; hence, as several inoculations were made, and with like results, I conclude that chiefly bacteria and only few micrococci existed in the hail in a quiescent or resting stage, and when supplied with proper nutriment and more favourable conditions, the organisms, suited to the circumstances, quickly turned from the quiescent state to one of the greatest activity. Of course I do not pretend there may not have been different varieties in the hail, for the organisms of rain-water have been found to determine butyric, lactic, ammoniacal and putrefactive fermentation; but what appears to me probable is, that one if not more amongst the organisms supported the temperature, whatever that might have been, that determined the formation of hail, remaining in an almost quiescent state, for I believe the Bacteria have their resting stage, and that the more advantageous conditions of nutriment and temperature speedily determined activity. The general mass of the jelly remained free from visible change. Before actual fluidity of the material occurred, close to the inoculated spot, numerous small, round, grey, finely granular, ascococcus-looking

patches made their appearance, and gradually coalescing, joined the edge of the inoculation. Of their nature I can say nothing definite. How they came there is rather puzzling, seeing none formed in other parts of the jelly.

At the same time, and in a similar manner, the same nutrient medium was inoculated with a speck of the old pellicle from the ice in the pan: the club-shaped rods did not, at this date and in this medium, undergo any visible change; but some of the minute organisms showed development, though not to any great degree, only exhibiting Brownian movement, whilst some of the same pellicle placed on the boiled white of egg at the same time as the former experiment with the pellicle from the hail, furnished on the second day minute organisms which, when seen in a droplet of distilled water, were not very active; but the club-shaped rods, if they multiplied, did so to an indiscernible extent. There was no chromogenous change at the point of inoculation, as with the pellicle from hail.

The minute organisms found in the melted hail-water scum, were no doubt derived from the rain-drops congealing round the air-borne dust-particles to which they were adherent, and afterwards slowly multiplied afresh on the surface of the melted hail. Some have doubted whether bacteria form part of the atmospheric dust; but the very careful experiments and cultures of M. Miquel, at the Montsouris Observatory, tend to prove that such bodies are suspended in the air and to be constantly found in rain, hail, and snow. Numerous figures are given. To avoid contamination in culture experiments, when objects are only for a short time exposed to unfiltered air, is a great source of difficulty. M. Miquel remarks in the 'Annuaire,' published this year, that snow, usually regarded as the great air-purifier, is not so in reality, for although it largely attracts the bacteria it meets with in its passage, it does not fix them like moistened earth; as a sudden squall cutting into the snow will often again bear them aloft. January and February have furnished him with the minima; October and November with the maxima in the gatherings. Cold he places the first, and extreme dryness the second agency in the destruction of atmospheric bacteria. Rainfall much lessens their number, whilst this again rises upon the succeeding dryness. He finds them ten times more numerous in the centre of Paris than in the country, for the same volume of air, and he gives the proportional numbers as, micrococci 93, bacilli 5, bacteria 2, for the first, and micrococci 79, bacilli 14, bacteria 7, for the second. He also furnishes the mean for the different months. The micrococci are pretty constant, the bacilli highest in April, May, July, and August, and lowest in November, January, and June; the bacteria nil in January, February, and June, and highest in the month of May.

The difficulty is to find a suitable medium for nourishing or rejuvenating all the aerial germs that have been gathered by the aspirator.

The great extremes of heat and cold to which the spores of many of the Schizophytes have been exposed without loss of vitality is a point of much interest. The Rev. Mr. Dallinger, in his careful experiments, found the death-points in dry heat, for the mature monads that he had studied, to range from 138° F. to 142° F., but their spores supported for five to ten minutes 250° to 300° F.; whilst the same heated in fluid were destroyed at 212° to 268° F. M. Van Tieghem found some micrococci and bacilli to flourish at 74° C. M. Miquel cultivated one form from the Seine at 70° C., which died when the temperature was raised to 72° C. Professor Frisch finds that the bacteria seen in diphtheritic exudation and in puerperal fever resist a *minus* temperature of 87·5° C. without destruction, and the bacilli spores to resist extremes of cold better than the rods. M. Miquel states that a particular *Bacterium* found in snow resisted a temperature of 26° to 30° C. below freezing for three hours, and for more than twenty days a mean temperature below zero of 2·5° C. The enumeration of such experiments might be greatly multiplied.

Drs. Cohn and Mendelsohn state that it required a powerful galvanic battery current of five elements to destroy the vitality of the bacteria they experimented upon.

Not to quote more largely, it seems quite incomprehensible that such minute organisms should be able to resist such extremes of temperature, and that the so-called mucous, gelatinous, albuminoid, cellulose, or by whatever name it may pass, covering, which is permeable to fluids, should be able to defend the living contents against such extraordinary variations of heat and cold. Here, under the hand of most careful experimenters, the reasonableness of previous doubt must give place and credence to the senses. Can it be that the envelope that surrounds the organism normally, when subjected to dry heat, dries so entirely and rapidly as to prevent the entire loss of moisture from within, or that the encapsulation, so to speak, is so perfect, that there is no room for the generation of high-pressure steam, and that under moist heat the coagulation is so effective that it shrinks the outer material so closely upon the contents, that steam cannot be generated except under rupture? Or can the rapid chemical changes they can effect, suffice to continue their vitality under such abnormal conditions?

We may largely theorize, though I fear only to record our ignorance, when we attempt to limit the manifestations of life by predeterminate lines, derived from the study of higher organisms, though amongst these there are some, as the Aphides, stated to

resist extreme cold, and in the case of seeds and chestnuts they are said to have survived the exposure to the very low temperature of $-100°$ C., and very lately in experiments by Messrs. de Candolle and Pictet the refrigeration was carried to $-80°$ C., the seeds germinating afterwards. I think experiments have also been made on hybernating animals, but I do not remember the exact temperature destructive of life. The minuteness, however, of the Bacteria almost forbids comparison with the other objects.

Such details I fear must be sadly wearying to those who take no special interest in the study of these micro-organisms, and to such I offer every apology. Nevertheless, I would ask them to try and estimate carefully the value of the study of these ubiquitous objects. They set up minute changes in some of the articles of our dietary as either invite or repel the organs of smell and taste. The numerous varieties found by M. Duclaux in the imperfect making of Cantal cheese, at once point to a large field of inquiry among the articles that are in our daily diet. They play a vast rôle as the grand scavengers in the silent destruction of lifeless forms and are thus beneficent agents; they are the companions of our life and accompany, if they do not originate, many depressing and fatal diseases, multiplying so rapidly in cases of lowered vitality of their host that they kill by their numbers, or perhaps by depriving the nutrient fluid of part of its oxygen, though this, as pointed out by Mr. Dowdeswell in his excellent article upon Septicæmia,* seems, in the smaller forms at least, improbable. The chemical changes induced by their own requirements may furnish noxious matters detrimental to the life of the higher organism—and harmless forms under new conditions may perhaps acquire such virulent properties, that in the state of spores the minutest quantity suffices when inoculated into the connective tissue of a healthy animal, if such have not acquired previous immunity, to cause severe illness if not certain death. Their importance, as affecting, on a vast scale, the life of man and of animals, invests them at least with the symbol of respect.†

It is only by cultivation that we can hope to distinguish the living from the lifeless, for may we not have before us in such as are gathered from the air, some that are dead, and some of what Dr. Phipson calls "fossil forms." Morphologically their resemblances may be so great that their differences are to our powers otherwise indistinguishable. Possibly some may be inert when cultivated in one fluid, and highly poisonous in another—as in living bodies.

* Quart. Journ. Micr. Sci., xxii. (1882) p. 66.

† M. Miquel found by the statistics of the mortality that occurred last year at Paris, that there were nine rises which closely corresponded each to a rise in the number of Schizophytes found in the air. He merely points out the interesting coincidence.

The necessity for a certain amount of the poisonous material to be introduced or acquired in the system to produce on the one hand immunity, or on the other hand fatal effects,—the alteration some undergo by exposure to air,—the re-acquirement of highly virulent properties after having had them lessened by culture, may, perhaps, point to the very variable results exhibited in contagious maladies, and malarial fevers, under similar exposures; some receiving the contagium, so to speak, at its first offer, others resisting for lengthened periods.

In the case of malarial fevers there are some points that furnish material for future study. I will mention an instructive case that came under my notice many years since. In the neighbourhood of Constantinople, and especially at the Dardanelles, malaria was endemic. *Assuming* malarial fever to be consequent upon the introduction into the system of the *Bacillus malariæ* of Klebs and Tomassi-Crudelli, this point for inquiry arose. A sailor had had at one of the ports in the East Indies a first and severe attack of intermittent fever, from which he speedily recovered, and remained free from any recurrence for thirteen years, although visiting various localities where such fevers were common; yet the same night that his vessel anchored, during the day, in the Golden Horn, he was seized with a severe attack of malarial fever, which necessitated his entry into the hospital. None of the officers or crew suffered similarly, though remaining many days at anchor. Are we to suppose the germs of the former malady remained quiescent in the system for the period of thirteen years, and that a few hours in a suitable locality sufficed to set them into activity and develope a return of the ague; or was he an individual very susceptible to malaria? I scarcely think so, as he was free at other ports where the malady was common. Again, should the second attack be supposed as unrelated to the first, under the assumption that he in some way imbibed the malaria in passing the Dardanelles, and that the incubation took three or four days to develop itself, or was it that out of all the places he had visited in the course of his voyages for thirteen years, this locality was the only one to furnish the necessary conditions for a return of the original malady, he being previously in good health?

In the malignant form, in the neighbourhood of the Dardanelles, I have known individuals die in the cold stage within sixteen hours. Had such imbibed a really toxic quantity of the malarial poison—I am expressly assuming the correctness of the *Bacillus malariæ* theory, which Dr. Sternberg, U.S.A., finds reason to doubt —and did the organisms multiply in such a short period throughout the system or in some vital organ as to thus speedily terminate life without any reaction, under every effort that time permitted?

Mr. E. L. Moss, Staff-Surgeon R.N., found, after forty-eight

hours, by ingeniously contrived experiments, organisms in the blood drawn from intermittent fever patients which he could not find in the fresh blood. It is questionable whether they were the same as the *Bacillus malariæ.*

Dr. Marchiafava contends for the correctness of the statements of Klebs and Tomassi-Crudelli, for he finds the blood of all parts of the body, in those stricken with malarial fever, to contain in the initiative or cold stage both barren and spore-bearing rods, and in the hot or fever stage, only free spores.

The cyclical course of various infectious diseases is attributed by Dr. Wernich and Professor Salkowski, from their careful experiments, to the destruction of the micro-organisms in the living body by their own products, i. e. they are destroyed by their own excreta.

What the term of life may be for the spores of these lowly forms awaits inquiry. The germs of *Bacillus anthracis* are said by M. Pasteur to have survived a period of twelve years, but how much longer, lies in the investigations of the future.

The medical digression has been purposely made to try and engage some of the waste microscopical energy of the members of this Society by showing that complex phenomena attributed to the action of such micro-organisms yet wait for intelligible and satisfactory answers. There is one hint I would throw out to those who need the stimulus of patient work, viz. to follow up the researches of M. Chappuis, by watching the effect of ozone upon the life of the Schizophytes. Such an inquiry may lend light to the obscurity that now veils some of the depressing catarrhal epidemics, such as influenza, &c.

Although much has already been accomplished, much has to be repeated. As yet we only touch the edge of this vast field for research. In it stands a complex problem for those to solve who have the time and patience to compete for even a fractional part. Fortunately encouragement comes from the important experiments now made in other countries, in the form of "preventive inoculation," from which, already, highly beneficial results have been achieved, conservative both to life and to the pocket. May we not apply to ourselves what has been so ably said by Dr. Burdon Sanderson in his recent Lectures upon Inflammation? "We are all of us, old and young, too apt to forget how slow and gradual is the process by which we come to a right understanding of objective facts. Let us be prepared to give equal credit to the past and the present, accepting what is new without losing sight of, much less rejecting, what is old."

[Since the foregoing was written, that indefatigable observer Dr. Koch has discovered another of the Bacteria which he, followed by Dr. Baumgarten, considers as the cause of tuberculosis—a disease

which is responsible for about one-seventh, if not more, of the deaths of our population. Dare we hope that further experimental research may ultimately arrive at some method of diminishing this frightful annual loss? Shall we get a clearer insight into what we term the law of heredity? Supposing infection ab utero, has it no limiting period of incubation? must all ages bend to its presence? I am not aware whether the organisms found in fowl cholera have as yet been discovered in the newly laid egg. The answer can only come from careful experimental inquiry. In it lies the hope of discovering the means of immunity, and I trust that, in spite of hasty and prejudiced legislation, such researches may yet be made in this country, as will conduce, not alone in this, but in other maladies, to the future welfare of both man and beast, so that we may say in the words of the poet:—

> " 'Tis worth a wise man's best of life,
> 'Tis worth a thousand years of strife,
> If thou canst lessen, but by one,
> The countless ills beneath the sun."]

XI.—*The Relation of Aperture and Power in the Microscope (continued).**

By Professor Abbe, Hon. F.R.M.S.

(*Read* 14*th June*, 1882.)

II.—*The Rational Balance of Aperture and Power.*

The discussion of Part I. relates to one and the same matter, viz. that from all points of view which come under consideration in the use of the Microscope, a certain *proportion* of aperture to power is the necessary basis of perfect performance.

The question we have now to consider is: whether it is possible to arrive at a more definite determination of that proportion than is furnished by the preceding somewhat general discussion of the question of wide and narrow apertures, and in particular, whether that can be done in such a way as to establish a rational standard for the *practical* construction of the Microscope. So far as I know, this matter has not yet been the subject of any kind of regular discussion, though it will be admitted, I presume, by every microscopist to be one of great practical importance. I have now directed my attention to it for more than ten years, not purely from theoretical points of view only, but by means of a long series of practical trials in which I had the advantage of the co-operation of Dr. C. Zeiss, of Jena, and I propose therefore to point out here the principles which, in my opinion, furnish an approximate standard for determining the proper balance of aperture and power in the Microscope.

For this, two distinct questions must be treated separately.

First, the relation of aperture to power must be considered in regard to the *entire Microscope* and we must ascertain what amplification of the ultimate image of the Microscope is useful, or necessary, for every given aperture, and conversely, what aperture is required for the proper utilization of a given amplification. If the subject admits of a scientific discussion at all, it must be possible to indicate the proper relation of aperture and amplification without having regard to the particular manner in which a given amplification is obtained by the co-operation of objective and eye-piece, provided, of course, that the amplification is obtained with the *best* possible quality of the image.

The second question is, what division of the entire power of the Microscope between the objective and ocular will fulfil the condition of a perfect image under a given amplification. This relates essentially to the practical aim of the discussion—the determination of the *focal length of the objective* which is required for the utilization of a given aperture.

* The paper (received 11th April) is written by Professor Abbe in English.

i. *Relation of Aperture to Power in regard to the entire Microscope.*

1. The first question may be dealt with under these two heads:—(*a*) What are the smallest dimensions of microscopical detail which are within the reach of any given aperture? (*b*) What visual angle is required for the distinct recognition of details of given dimensions? If these can be answered in a reliable manner, the first question will have been disposed of.

The smallest dimensions which are within the reach of a given aperture are indicated with sufficient accuracy by taking the limit of the resolving or separating power of that aperture for periodic or *regular* structures, i. e. the minimum distance apart at which given elements can be delineated *separately* with the aperture in question. The numerical expression of that minimum distance is

$$\delta = \tfrac{1}{2}\frac{\lambda}{a},$$

where a denotes the numerical aperture and λ the wave-length of light; a fair average is obtained for the latter element (with observations with the eye and white light), by taking $\lambda = 0 \cdot 55\ \mu = 0 \cdot 00055$ mm.; i. e. the wave-length of green rays between the lines D and E, very near to the point of maximum visual intensity in the diffraction spectrum.

Though this expression applies in strictness only to the visibility of periodic structures composed of regularly arranged elements, it may be taken as an *approximate* measure of delineating power in general, i. e. in regard to *structures of every composition.* My theoretical investigations and experiments show that with objects of *every* shape and arrangement, the microscopical image will not present any indications of structure, the dimensions of which are perceptibly below the value of δ, given (for any aperture) by the above formula. Prominences of any shape on the outline of a coarser object, for example, will disappear more and more as their dimensions approach the value of δ for the aperture in use. Isolated elements of triangular, or quadratic, or rectangular figure will look more and more *alike* (becoming more and more circular or elliptical in form), as they diminish in size to the value of δ.* The loss of diffracted light attendant upon the limitation of the pencils by the lens-opening, changes or obliterates those details which are beyond the limit of the resolving power. Consequently the microscopical image of an object of any composition whatever, will always be *dissimilar* to the object to the same extent; and the limit of resolving power therefore indicates the limit of *similar* or *correct* delineation generally.

* I have verified these theoretical inferences, for small apertures, by many experiments, with objects of very different nature.

Hence every aperture is fully utilized when the amplification of the entire Microscope is sufficient for a distinct and convenient observation of details corresponding to the value of δ. Lower amplifications would not exhaust the aperture, because indications of *real* structure which exist in the image, would remain hidden from the eye. Higher amplifications, on the other hand, will not promote the recognition of the objects, because all the indications of minuter scale which they might perhaps display, do not exist in the objects, but belong to the image *only*—they are simply modifications of the image due to the aperture in use. Such higher powers would therefore afford nothing more than an exaggeration of those features of the image which are not conformable to the real nature of the object.

We have now therefore reduced the problem under consideration to the single question: What amplification is necessary and sufficient in order to display the δ of every aperture, under that visual angle which is required for distinct vision?

The facts of observation which are within the reach of every microscopist, afford all necessary data for an *approximate* determination of this amplification. The striation of an ordinary specimen of *Pl. angulatum* becomes visible to a very sharp-sighted eye under an amplification of 150 diameters. As the closeness of the lines is about $0 \cdot 5\ \mu$ (50,000 to the inch) they are thus recognized under a visual angle not much exceeding $1'$ of arc. But *distinct* and *convenient* observation for an average eye will in any case require a much higher power; *how* much higher, will of course vary with different individuals. I am, however, sure to leave sufficient latitude for personal diversities in assigning 300 and 600 diameters as the limits of *useful* amplification for details of these dimensions. In observing the diatom, no one, I presume, will deny the advantage of increasing the power if it is below 300; and on the other hand, no one will admit any further advantage in going beyond 600, provided the observation is made with an aperture not exceeding $0 \cdot 6$, which shows the striæ, *but nothing more.**

It may be inferred from this example, in accordance with many similar facts, that satisfactory observation requires that the smallest detail of the microscopical image shall be displayed under a visual angle of not less than $2'$ and not more than $4'$, approximately; angles which correspond very nearly to the amplifications 300 and 600 for dimensions of $0 \cdot 5\ \mu$.

This admitted, we obtain at once the number of diameters which are required for properly utilizing any given aperture. If a dimension δ is to be displayed under a visual angle of v minutes of

* Much higher powers may of course be utilized in the observation of *Pl. angulatum* with objectives of wide aperture. In this case, however, the image contains indications of form upon the markings of much minuter dimensions.

arc, the necessary amplification, N, for a distance of 250 mm. or 10 inches (1′ being = 1 : 3438) is

$$N = \frac{250}{3438} \cdot \frac{v}{\delta},$$

and substituting for δ its equivalent in terms of the aperture $\left(\frac{\lambda}{2a}\right)$ we obtain the general formula :—

$$N = \frac{250}{3438} \cdot \frac{2\,a\,v}{\lambda};$$

or, if λ is taken = 0·00055,

$$N = 264{\cdot}5\ a\,v.$$

By introducing into this formula $v = 2'$ and $v = 4'$ respectively we obtain the figures of *useful* amplification for a series of different apertures as shown in Table I.—useful, that is, so far as *delineating power* is concerned, putting aside for the moment any question as to the *illumination* of the object, which, as explained hereafter, allows of somewhat greater apertures.

TABLE I.

Aperture.	Aperture-Angle (air).	δ, Measure of the least attainable Detail.	N, Amplification for obtaining a Visual Angle of	
			$v = 2'$	$v = 4'$
	°	μ		
0·05	5·7	5·50	26	53
0·10	11·5	2·75	53	106
0·15	17·2	1·83	79	159
0·20	23·0	1·37	106	212
0·25	29·0	1·10	132	265
0·30	35·0	0·92	159	317
0·35	41·1	0·79	185	370
0·40	47·2	0·69	212	423
0·45	53·5	0·61	238	476
0·50	60·0	0·55	264	529
0·55	66·7	0·50	291	582
0·60	73·7	0·46	317	635
0·65	81·1	0·42	344	688
0·70	88·8	0·39	370	741
0·75	97·3	0·37	397	794
0·80	106·3	0·34	423	846
0·85	116·4	0·32	450	899
0·90	128·3	0·31	476	952
0·95	143·6	0·29	503	1005
1·00	180·0	0·27	529	1058
1·05	..	0·26	555	1111
1·10	..	0·25	582	1164
1·15	..	0·24	608	1217
1·20	..	0·23	635	1270
1·25	..	0·22	661	1323
1·30	..	0·21	688	1375
1·35	..	0·20	714	1428
1·40	..	0·19	741	1481
1·45	..	0·18	767	1534
1·50	..	0·18	793	1587

Conversely we can obtain the aperture a, which is sufficient for the utilization of a given power of N diameters, provided a visual angle v' is required for the least detail within the reach of that aperture. This is given by the formula

$$a = \frac{N}{264 \cdot 5} \cdot \frac{1}{v}.$$

Table II. shows the values of a corresponding to different amplifications under the supposition of a visual angle $v = 2'$; it exhibits, therefore, the *maximum* aperture which can be admitted as useful for any given power under the above assumptions. The assumption of any other visual angle as necessary for distinct vision of the least detail, would change a in the inverse proportion of v, so that for $v = 1'$ we should have twice the figures of a given in the second column of the table, and for $v = 4'$ one-half.

TABLE II.

N, Amplification for 250 mm.	a, Aperture for a Visual Angle of the least detail, $v = 2'$.	Aperture-Angle (air).
		°
10	0·019	2·2
20	0·038	4·4
30	0·057	6·5
40	0·076	8·7
50	0·095	10·9
75	0·142	16·3
100	0·189	21·8
150	0·284	33·0
200	0·378	44·4
250	0·473	56·5
300	0·567	69·1
350	0·662	82·9
400	0·756	98·2
450	0·851	116·7
500	0·945	141·8
600	1·134	
700	1·323	
800	1·512	
900	1·701	
1000	1·890	

Though these figures cannot of course pretend to be more than an approximation to the actual requirements under various given conditions, yet they will indicate with sufficient accuracy the *limits* of useful power; in that the delineating power of any given aperture cannot be fully utilized when the number of diameters (obtained *with a really good quality of the image*) is *much* below the minimum figures of the table; and that, on the other

hand, we shall have an *empty* amplification, which does not improve the representation of the objects, if the power should go *much* beyond the maximum figure.

The salient fact suggested by the two tables is the relatively *low* figures of amplification which are sufficient for very wide—in particular for the widest—apertures; and, conversely, the small apertures which are sufficient for the low powers of the Microscope. I do not, of course, intend to assert that, under particular circumstances and for particular purposes, much higher figures of amplification than are shown in the tables may not be very useful or even necessary; as, for instance, for counting, measuring, drawing, &c. What I wish to convey is, that in the present state of the Microscope they are not required and are not even advantageous, for *research*, i. e. for the proper *recognition* of the objects. A visual angle, for the minutest elements of a microscopical image, of 2′, or at all events of 4′ (which is about the eighth part of the moon's apparent diameter), is certainly quite sufficient for distinct observation. If indications of shape or arrangement should be found in the image, which are too minute for the powers given above, they must be at any rate of minuter dimensions than the values of δ assigned by the first table. Indications of that kind—if such there be—have no true relation to the objects, but are attributes of the image only—mere optical phenomena, dependent upon the limitation of the delineating pencils by the lens-opening.

Apart from all theory and experimental demonstration in support of the principles in question, the practical experience of microscopists has sufficiently established that there *is* a limit to the performance of the Microscope, and one depending on the aperture of the objectives in the manner pointed out above. No kind of microscopical object can possibly afford in any respect more favourable conditions for the recognition of minutest details than those very expressive (and at the same time very simple and regular) structures of the silica skeleton of diatoms. But even with this kind of object not one *trustworthy* observation is on record in favour of the assumption that any given aperture, be it either 0·3 or 1·40, could reach a finer detail than is assigned by the table above, whilst there are many indubitable proofs that these theoretical limits may be as closely reached as can be expected, having regard to the difficulty of a strict determination of the actual circumstances of observation.

The low figures of amplification suggested above, even for the widest attainable apertures—low in face of the views of many microscopists—are an unavoidable inference from the principle under consideration. In support of this inference I may, however, appeal to the evidence of many experienced naturalists who have done valuable work in lines of research dealing with the most

minute and delicate objects, and who agree that all real increase of our knowledge, even in these branches, has been originally obtained, or at least could have been as well obtained, by powers not much exceeding 1000–1200, whatever kind of lenses may be in question.

2. I cannot, however, restrict myself to the suggestion that *excess of power*, in proportion to the aperture in use, is simply of no advantage for the recognition of microscopical objects, but I must go further still, and express the opinion that excessive power is, or at least may be, a positive obstacle to *correct* recognition, because it will unavoidably lead the observer to take mere optical phenomena of the images for real attributes of the objects. The following considerations will justify this view.

If we observe a frustule of *Pl. angulatum* with the small aperture of about 0·6, in which case one set of lines only is exhibited at once, we may obtain a well-defined image of these lines under a power of 1000 diameters, or even more, provided a relatively short focal length of the objective and a moderate eye-piece are applied, and the illumination is effected by a very narrow beam of intense light. This power *apparently* displays much more than a lower power of 350 or 400 diameters with the same aperture. We see the striæ as broad ridges or grooves widely separated from one another, and we recognize a distinct proportion between the breadth of these apparent ridges and their interspaces, which is 1 : 1 very approximately; whilst with 300 diameters we only catch just the fact of a striation, and nothing more. In this case now, we know that all details which are given by the 1000 diameters are mere optical illusions, because we are able to control and correct the indications furnished by that power with the low aperture, by the image presented by an equal power, but having an aperture of 1·2. But if it had happened that a system of wider aperture than 0·6 had not hitherto been made, microscopists would certainly have believed in the existence of ridges and grooves of equal breadth on the scale of *Pl. angulatum*. In this example it is unquestionable that the image obtained with an aperture of 0·6 under 300 diameters is *less far* from the truth than the image with the same aperture under 1000 diameters. The *indeterminate* striation is an indication of real structure, inasmuch as there *are* equidistant rows of elements in the diatom, which must appear as striæ as long as the elements themselves remain occult; the exhibition of these rows as determinate ridges and interspaces *with a distinct relation of breadth* is a positive adulteration of the image of the structure.

What holds good for an aperture of 0·6 must also hold good for every larger aperture *relatively*. I have before me Dr. Woodward's magnificent photographs of *Amphipleura pellucida, Pl. angu-*

latum, and other diatoms, taken with the best wide-angled lenses under amplifications of about 3000 and more diameters. Now the *Amphipleura* of these photographs, taken with apertures of 1·2–1·3, is the true equivalent of the *Pl. angulatum* of 1000 diameters with only 0·6 aperture. It shows the same determinate and energetic striation *with equally broad ribs and interspaces*, which are always seen when the closeness of the structural elements is not far from the limit of separation for the aperture in use. Theory and experiment show that these details of the image have no relation to the real composition of the object, that they exhibit nothing more than *typical* pictures of rows of elements of any shape and magnitude whatever, when their closeness approaches the value of δ corresponding to the aperture. It would be contrary to all analogy to expect that in *Amphipleura* alone we should have real bands or ridges, and not, as in other diatoms, distinct elements of double periodic arrangement with different closeness in different directions. This admitted, the enhanced expressiveness and determinateness of the image with the higher power is just the opposite of enhanced recognition, because the eye is caught by features which are entirely foreign to the object. If I wanted to show to any one what the Microscope has *really* revealed of the structure of diatoms, I should request him to inspect the said photographs at a distance of three or four feet, in order to restore the smaller visual angle corresponding to an amplification of about 1000 diameters. What he is able to recognize under these circumstances are the *vestiges* of true structure—indefinite, perhaps, but not falsified; what he sees *more* under greater visual angle is nothing but the display of dissimilarity of object and image arising from the lack of aperture. The 3000 or 4000 diameters could improve the recognition of the *real* structure, only if they were obtained by apertures of 3·0 or 4·0.*

It is by no means otherwise with the very minute objects of entirely different lines of research. If the image of a bacterium or a very delicate flagellum is exhibited under a power of 3000 diameters with more distinctness, as regards shape and magnitude, than is possible with one of 1000, the surplus will always be a surplus of mere optical dissimilarity.

The effects of excess of power in the Microscope may be illustrated by similar facts of astronomical experience. Astronomers

* The figures of the tables should not, however, be applied directly to photographic performance, but the powers indicated for each aperture should be *increased* in the proportion of 0·41 : 0·55 (3 : 4 approximately), and the aperture corresponding to a given power *diminished* in the same proportion. Owing to the shorter wave-length of the rays of maximum chemical intensity, the value of δ for every aperture is proportionately smaller in photographic than in ocular observation.

know very well that the most *trustworthy* power of a telescope is not the highest power which the instrument will bear, but that power which has a certain relation to the diameter of the objective. If they use a higher amplification than about 40 per inch of the diameter of the objective (i.e. 120 for a 3-inch, 400 for a 10-inch objective) they begin to detect diameters of stars which have no diameters. A very good 3-inch objective will, indeed, show more under a power of 300 than of 100, apparently; just the same as with a very good wide-angled Microscope-lens in regard to 3000 and 1000 diameters. In fact, the 300 diameters of the 3-inch will reveal, with somewhat bright fixed stars, very neat and distinct disks which are invisible, or nearly invisible, under a power of 100. But these disks disappear at once, when the amplification of 300 is obtained with an objective of 9 inches diameter.* Astronomers are accustomed to apply much higher powers than 40 per inch for various purposes; but they do *not* apply them whenever they want to recognize the *true* shape and magnitude of their objects.

It is just the same in the Microscope. The greatest possible approximation of the image to a true projection of the object is not obtained by the highest powers, but by those powers which are just capable of exhibiting to the eye the least dimensions of real structure within the reach of any given aperture.

I invite the particular attention of microscopists to this subject, as it is in my opinion of great practical importance in regard to the proper *use* of the Microscope. For my present purpose I may confine myself to the statement that it does not belong to the rational aim of microscopical optics to enhance the *amplification* of the Microscope beyond those moderate figures which are sufficient for utilizing the attainable apertures; the rational aim is rather to obtain the best possible accomplishment and the most favourable conditions, for the use of these moderate amplifications.

3. So much as to the proper relation of aperture and amplification at the *upper* end of the scale of microscopical performance, where the question is of the largest attainable apertures and highest useful powers. In regard to the *lower* end of the scale, the suggestions indicated by Tables I. and II. will require some further remarks.

So far as the principle is admitted on which the computation of the tables has been based, we must consider the small apertures assigned for the lower powers of the Microscope as sufficient,

* The physical conditions of the phenomena in question are not *the same* in the telescope and in the Microscope, but yet very similar. In both cases the effects do not arise from deep oculars—as is often assumed—but depend only on the relation of the total amplification of the instrument to the aperture.

provided a visual angle of not less than 2′ is required for the smallest detail within the reach of every aperture. An increase would be a matter of necessity only if a given observer should consider a smaller visual angle, say 1′, as sufficient for distinct observation. On the other hand, it is certain that a surplus of aperture is no drawback by itself, but only in regard to certain practical points, which have been spoken of in the first part of this paper. Among these are some which argue in favour of *small* apertures (penetration, working-distance, insensibility of the corrections, &c.), and one which is in favour of *increased* aperture (brightness of the image). The proper function of the theoretical considerations of the foregoing paragraphs cannot therefore be to establish an *absolute* rule, but rather to afford a proper basis for finding a rational balance between the various requirements of the practical use of the Microscope.

Regarding those in which the advantage is always on the side of the *lower* aperture, it will be obvious that all of them become less and less important as lower apertures and lower powers are in question. As has been pointed out in the first part, restrictions of the working distance and inconvenient sensibility of the systems (unsteadiness of the corrections for different thicknesses of the covering glass, &c.) are not met with as long as the aperture does not exceed 0·25 (about 30°) and even with somewhat greater apertures, up to 0·5, they do not occur in any very obnoxious degree. The third element, the penetration of the Microscope, has been more fully discussed on another occasion,* where it was shown that with decreasing amplification the *actual* penetration, i.e. the depth which is accessible to the eye with *one* focussing, is more and more the result of the accommodative faculty of the eye and more and more independent therefore of the aperture. With very low powers, not much exceeding 50 diameters, a normal eye has a perceptible amount of depth of vision without any regard to the aperture. The lower the power, therefore, the more liberty is left for increasing the aperture in proportion to the power without any perceptible disadvantage in respect to the various points above mentioned.

There is, as I have said, *one* element in the performance of the Microscope in which a *surplus* of aperture will be a benefit, viz. the illuminating power, or the brightness of the image. It would, however, be a great mistake to expect that this should be without any limits or conditions, as the following considerations will show:—

So far as the illumination of the objects by transmitted light is effected with light of a given intensity, and the illuminating pencils utilize the whole aperture of the objective, the brightness

* See this Journal, i. (1881) p. 689.

of the microscopical image depends solely on the diameter of the pencils at their emergence from the ocular, and is in the direct proportion to the square of that diameter. This diameter (d) is strictly expressed by the simple formula

$$d = 2\,a \cdot \frac{l}{\mathrm{N}} \quad \left(\text{or } d = 2\,l \frac{a}{\mathrm{N}}\right);$$

if N denotes the amplification of the ultimate image for a distance of vision $= l$, and a the numerical aperture of the system. If we have a narrower illuminating pencil, which does not fill the whole opening of the system, the numerical aperture corresponding to the angle of the illuminating pencil must be substituted for a, instead of the full numerical aperture of the system. The diameter of the emergent pencils, and consequently the illuminating power, is entirely independent of the particular composition of the Microscope (objective, ocular, and length of the tube), and is solely determined by the aperture and the total amplification (the accidental losses of light by reflection and absorption being disregarded). By giving values to l and $\frac{a}{\mathrm{N}}$ we obtain from the above formula the diameter d in millimetres. Under the assumptions made in the computation of the figures of the second column of Table II. (i. e. $\lambda = 0 \cdot 55\ \mu$ and $v = 2'$) we have a *constant* ratio of a : N, viz.:—

$$\frac{a}{\mathrm{N}} = \frac{1}{2\,(264 \cdot 5)};$$

and taking $l = 250$ mm. and substituting those values in the above formula we have

$$d = \frac{250}{264 \cdot 5} = 0 \cdot 95 \text{ mm.},$$

consequently the same diameter d for all powers, and always the same brightness of the image therefore, provided the different apertures are fully utilized by the incident illuminating pencils.

By increasing the values of a assigned for every power N by Table II. we enlarge the diameter of the emergent pencils in the same proportion; we should, for example, have $d = 1 \cdot 9$ mm. throughout, if the apertures—so far as this is possible—were increased in the ratio of 1 : 2, which would correspond to the assumption of a visual angle $v = 1'$ for the least accessible detail. It is obvious, however, that larger apertures can be of advantage only so long as the value of d does not exceed the diameter of the pupil of the eye under the actual conditions of microscopical observation; for if this should happen, the iris of the observer must stop-off the marginal part of the lens-opening exactly in the same way as if a diaphragm were placed on the objective.

Moreover, in microscopical observation—except under very faint illumination—the iris of a sound eye always contracts to a relatively narrow diameter, generally not more than 2 to 2·5 mm. Whilst, therefore, so far as delineating power alone is concerned, the largest useful aperture (for $v = 2'$ as in Tables I. and II.) is $\frac{a}{N} = \frac{1}{2\,(264 \cdot 5)}$ or $a = \frac{N}{529}$, the *maximum* aperture for every amplification of the Microscope will be given by the general formula above, if d is taken $= 2 \cdot 5$. We then obtain, from $a = d\,\frac{N}{2\,l}$,

$$a = 2 \cdot 5 \cdot \frac{N}{500} = \frac{N}{200};$$

and conversely $N = 200 . a$ as the *minimum* power required to enable the eye to admit all rays which emerge from the ocular. An aperture of 0·5 (60°) will therefore be useless in *every* respect (in regard to light as well as delineating power) as long as it is applied with powers of less than 100 diameters, and the same will be the case with an aperture of 0·25 (29°) for all powers below 50 diameters. Moreover, *proper* utilization of the rays which are admitted through a given aperture, will require still further restriction. For if the diameter of the pencils at their emergence from the ocular should closely approach the pupils' diameter the least motion of the eye will cause a stopping-off of this or that portion of the aperture. The observer will therefore seldom utilize the full pencil, and will have the awkward sensation of a continual change of the illumination of the image.

All this considered, it must be concluded that the *utmost* amount of aperture which can be really useful under the general circumstances of microscopical work, will be, for every power, about *twice* the figures indicated by the second table. This corresponds to an increase of the emergent pencils to a diameter of nearly 2 mm. (1·9 mm). Every larger proportion between aperture and power must be considered as decidedly irrational, because it is not only *waste* of aperture in every respect, but at the same time a positive disadvantage for convenient and proper observation.

Up to the limit here assigned, I admit the benefit of increased aperture, so far as the *lower* and *lowest* powers are in question, for which the other requirements—as has been shown—do not impose greater restrictions. In my opinion, the benefit of the increase is, however, not so much the gain of light by itself, but rather the advantage, *that narrower illuminating pencils, which do not fill up the whole aperture of the objective, may be applied without inconvenient reduction of light.* The smaller apertures which are sufficient for properly utilizing the delineating power of the objectives would also be quite sufficient in regard to light, provided the inci-

dent beam always utilized the full area of the objective. In point of fact, a system of $a = 0 \cdot 2$ (23°) applied with a power of 106 diameters will not show any want of light under that condition, even with dull daylight. The deficiency which, under all circumstances, is found in the use of high powers (notwithstanding correspondingly wider apertures) has no other cause but that we are not allowed to apply illuminating pencils as large as the full aperture of the Microscope. With the exception of some particular cases, the utilization of wide apertures in observing delicate objects will always require such *narrower* incident beams of light (generally of no greater angle than 30–40° in air) as utilize *directly* a small portion of the aperture-area only; the effect of the wider aperture being to collect those rays which are dissipated to large angles by the structural elements of the objects. The actual brightness of the image which is obtained under these circumstances is of course much less than it would be if an illuminating pencil equal to the full aperture could be employed. The proper effect of low apertures is, it is true, much less dependent upon the reduction of the illuminating beams. Nevertheless, such reduction—by means of diaphragms below the preparations—is an important benefit in many observations. For that purpose it is of practical importance that the aperture should be *greater* than would be required for the brightness of the image under full illumination. If *twice* the value of a assigned by Table II. is admitted for the several powers, these powers will still afford sufficient light, even if incident pencils of half the aperture only are used for illumination, and three-quarters of the clear area therefore is left for the utilization of dissipated rays.

4. We have now all necessary data for defining, at any rate in outline, a *rational standard* for the ratio between aperture and power in regard to the *entire* Microscope, i. e. the amplification of the *ultimate* image (without considering at present the participation of objective and ocular).

(1.) So far as those apertures are in question which cannot at the present time be overstepped, the aim must be to obtain the most perfect performance for those powers which are just sufficient for the full utilization of the delineating capacities of these apertures. The figures of N assigned by Table I. may thus indicate the particular aims for the various kinds of lenses—dry, water-immersion, homogeneous-immersion—in regard to those values of a which must be considered as the practical limits for these various systems (i. e. about $0 \cdot 95$ for the dry, $1 \cdot 25$ for the water-immersion, and $1 \cdot 45$ for the homogeneous-immersion systems respectively). For the full development of every system a reasonable latitude for further increase of power, beyond the limits of strictly useful powers, must, however, be left.

(2.) So far as the medium powers are in question, which are *below* the limits of useful powers for the maximum apertures, but still *above* those amounts which could be obtained by very moderate apertures, a somewhat strict *economy of aperture* is indicated by important considerations in regard to the general demands of scientific work (penetration, working distance, &c.), because the disadvantage of superabundant aperture will be always greater than the possible benefit. For the medium powers in use, the figures of Table I. will therefore give the approximate limits of latitude which may be deemed reconcilable with a rational construction of the Microscope for *scientific work.*

(3.) Concerning the lower and lowest powers, a gradually increasing latitude is left for the application of wider apertures than would be theoretically necessary in regard to the delineating capacity required for these powers. A surplus of aperture increasing up to about 100 per cent. for the lowest amplifications, will be in favour of the *illuminating power* of the Microscope; a considerably greater excess will at all events be mere waste.*

* The concluding part of the paper—ii. *Division of the Entire Power of the Microscope between Objective and Ocular*—will be printed in the next number of the Journal.

XII.—*Description of a Simple Plan of Imbedding Tissues, for Microtome Cutting, in Semi-pulped Unglazed Printing Paper.* By B. Wills Richardson, F.R.C.S.I., Vice-President University of Dublin Biological Association.

(*Read* 10*th May*, 1882.)

I am emboldened to publish the following description of a method for imbedding tissues of suitable consistence for microtome cutting, as it may have some claim to originality, imbedding in semi-pulped paper being unnoticed in any of the standard works on microscopic manipulation which I have had opportunities of searching. Be this as it may, very thin and perfect sections can be cut with rapidity in semi-pulped paper, from either animal or vegetable structures of sufficient firmness to remain uninjured while being sent home in the microtome well. I think, however, that imbedding in semi-pulped paper will probably be found to have a more extended range of usefulness for vegetable section-cutting rather than for cutting animal structures.

Although tissues submitted to the process should have a certain amount of firmness, as I have just observed, they should not, on the other hand, be so dense as to offer much resistance to the knife, very unresisting structures being unsuitable for this mode of imbedding.

The diameter of the tissue to be cut should, when feasible, be one-quarter of an inch less than the diameter of the microtome well. Indeed, a microscopist's laboratory ought to be provided with microtomes having wells of different diameters that both time and tissues may be economized.

Stems of plants previous to cutting may, with advantage, be stored in methylated spirit for a few weeks; and animal structures, in whatever fluid has been found most appropriate for their preservation and, if necessary, for their hardening.

I shall now give the steps of this easy method:—

Cut strips, eight to nine inches long, from white unglazed printing-paper, the width of each strip to be a little more than the length of the structure to be imbedded. Transfer the latter from the preservative fluid to filtered water, in which leave it for about half an hour, then dip one of the strips of paper in the water for a few seconds, remove it and drain the water rapidly off its surfaces. Take the structure to be cut out of the water, apply one end of the wetted paper to a portion of its circumference, and roll the paper around the structure as closely as the paper will allow of without tearing. If necessary, apply more wetted paper until both the paper and inclosure form a plug that should require a little

pressure for sending it home in the microtome well. If too much paper has been applied, tear off the superfluous portion until the desired calibre is attained.

The paper when wetted will, of course, stretch, but a little practice soon teaches the operator to roll it with only the tightness necessary for allowing the imbedded tissue to be cut without break.

In careful hands dozens of perfect sections may be cut in half an hour from very delicate stems $\frac{1}{8}$ of an inch in diameter, or from the delicate aereal-roots of certain orchids. But I should mention that a pine-apple stem $\frac{6}{8}$ of an inch in diameter has afforded me most perfect sections when imbedded in the semi-pulped paper.

Up to the present time (April 1882) the only animal structures I have had leisure to imbed and cut in semi-pulped paper were decalcified human teeth, and a diseased external iliac artery removed from the body of a child, one of whose lower extremities I removed by amputation at the hip in March 1879.

From the "dentinal cartilage" I obtained several thin and instructive specimens.

The artery did not bear the knife to my satisfaction, having partially "rotted" from a too prolonged immersion in Müller's fluid.

Further experience of pulped paper as an imbedding medium may lead to an extended use of the paper for animal-tissue section-cutting. But I prefer to conclude here, at all events, with a stronger recommendation in favour of pulped paper for supporting vegetable tissues in the well of the microtome under the restrictions I have mentioned. It is almost superfluous to add that each section should be floated off the knife in water, and that a little of the latter should be carried by the blade to the semi-pulped paper in the well, to maintain it at the requisite degree of saturation for efficient cutting.

The advantages which I consider the method to possess are:—(1) Facility in application; (2) almost unlimited application in vegetable section-cutting under the restrictions above mentioned; (3) rapidity in cutting; (4) the tissues are equally supported; (5) cleanliness; (6) heat not being used, the subsequent staining of sections is more equal.

XIII.—*Note on the Rev. G. L. Mills' Paper on Diatoms in Peruvian Guano.* By F. Kitton, Hon. F.R.M.S.

(*Read* 14*th June*, 1882.)

In the last volume of the Journal, p. 865, Mr. Mills has figured and described a new species of *Auliscus, A. constellatus.* After reading his description and carefully examining his excellent figures, I was satisfied that his species was identical with that described by Herr Janisch in his 'Zur Charakteristik des Guanos,' Breslau, 1861–62, as *A. Stockhardtii;* it is also figured in Schmidt's 'Atlas der Diatomaceen-Kunde,' Tafel xii. figs. 11–13. Schmidt remarks that fig. 13 = "*A. racemosus* Ralfs (Greville Monograph of the Genus *Auliscus,* T.M.S. vol. xi. 1863, p. 46, pl. iii. fig. 18) doch Janisch's Benennung ist älter." This is undoubtedly correct, and Ralfs' specific name must be deleted.

I communicated the result of my examination to Mr. Mills, who at once admitted the correctness of my views, and, moreover, had the kindness not only to send me the specimens of his supposed new species, but also most generously gave me his specimen of *Aulacodiscus Kittoni* with fourteen processes. On examining this I congratulated myself on possessing a probably unique but certainly a very beautiful state of this species. Examining it again a few days afterwards, I found, in consequence of the balsam being still soft, that a valve of *Aulacodiscus Comberi* had partially slipped over it. I resolved upon remounting it, and succeeded in placing it on another slide; during the process I caught a glimpse of the *f. v.*, which induced me to examine it again very carefully with a binocular and $\frac{1}{4}$ objective, when to my disappointment I found that our supposed fourteen processed *A. Kittoni* was composed of the two inner valves (each with seven processes) of a double frustule; these were in close proximity—in fact, the two convex surfaces touched each other, the elevations on one surface fitting into the concavities of the other, thus accounting for the fact, noticed by Mr. Lewis, that the processes appeared "all in the same plane, and all equally and distinctly defined." The number of processes in *Aulacodiscus* and *Eupodiscus* are now generally admitted to be of no specific value, but it is more constant in some species than in others, e. g. *A. formosus.* I have never seen more than four processes, and on some valves I have observed as few as three, but in every case they were abnormal forms. In all other species the number is more or less variable. In a pure and recent gathering of *A. Kittoni* I have seen no valve with more than six processes, four being the usual number, but abnormal forms are by no means rare. I have seen a six-rayed valve with four of the rays at right angles to each other,

the remaining two being close to the opposite rays (processes). The most remarkable abnormally is a valve without process or *αὔλαξ*, but with the former faintly indicated near the margin.

It is only right to add that these remarks on Mr. Mills' paper have been written at his request, as he does not wish an error to remain uncorrected.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Division of Embryonic Cells in the Vertebrata.†—L. F. Henneguy, in studying cell-division as exhibited in the ovum of osseous fishes, finds that that of the trout, on the third or fourth day after fecundation, if treated with a mixture of acetic and picric acids, is the best adapted for this investigation; the cells are then seen to be formed of a finely granular protoplasm, and contain a nucleus of some size.

The nucleus of a cell in a state of repose contains a plexus, formed of small irregular granulations, which are especially well stained by carmine. The nucleolus is only a little larger than the other granulations. Soon there appears around a clear space, of which the centre is occupied by the nucleus, very fine clear lines, which are set along the rays of the cell, and which together form an aster; this aster elongates and becomes elliptical, as does also the nucleus; the aster then divides, and the two halves each form a fresh aster; at this moment the membrane of the nucleus disappears, and the rays of the aster penetrate into the interior. The plexus now breaks up into a number of small rod-shaped bodies; these become set at the extremities of the rays, and form the so-called equatorial plate. Gradually the rods diminish in size but increase in number, and fuse to form a pectinate figure. The body of the cell then begins to be constricted in its middle, the rays of the aster disappear, and the connective filaments alone remain to unite the two nuclei, until at last the cells become completely separate. The new nucleus, due to the fusion of the rods, is highly refractive, and is intensely coloured by reagents;

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial " we.")

† Rev. Internat. Sci. Biol., ix. (1882) pp. 363-5.

as it increases in size, there appear the limiting membrane and the internal plexus.

At a later stage of development, when there has been multiplication of the cells, these become smaller and smaller, and the asters gradually become quite indistinct. In the earliest stages of segmentation the process of division is more difficult to follow, owing to the large size and very granular contents of the cells; on the first and second day the cells become so uniformly tinted that the nuclei are with difficulty made out. As the cells diminish in size the action of the colouring matter becomes more and more confined to the nucleus, and the author is of opinion that the chromatin of Flemming is at first uniformly distributed through the cell, and that it gradually separates to form a constituent of the nucleus.

Genesis of the Egg in Triton.*—Mr. T. Iwakawa records the result of observations on the genesis of the egg of the common Triton (*T. pyrrhogaster* Boje), in which he describes the manner of depositing the egg (the female turning upside down so as to place it *under* the leaf or stem), the structure of the ovary, origin of the ovum and Waldeyer's "epithelial islands" (the author's view being that the ovum does have an epithelial origin), the formation of yolk-spherules, the vitelline membrane, the germinal vesicle, and the "yolk-nucleus."

Formation of Fibrine.†—In 1879 Dr. Norris described the alleged discovery of a third corpuscular element in blood in the form of colourless disks, which he considered to be an earlier stage of the red corpuscles.‡ This was criticised by Mrs. Ernest Hart in the following year,§ her view being that they were red corpuscles that had undergone post-mortem changes prior to taking part in the formation of fibrine.

Continuing her investigations and repeating the experiment of "isolation" ‖ a great number of times, she began to observe that the appearances changed according to the length of time which elapsed between the spreading of the layer of blood between the two glass surfaces and the moment when the cover-glass was raised, and thus discovered that a whole series of phenomena could be traced, leading from the pale or colourless corpuscle up to the complete formation of networks or bands of fibrine. In developing this method of working it was found that the staining reagents recommended by Dr. Norris were not sufficiently powerful to bring out all the details that could be observed on the glass surfaces, and after many trials a highly concentrated solution of nitrate of rosanilin in absolute alcohol was found to be the best staining reagent. The method adopted was to detach the cover-glass from the slide after the corpuscles had been fixed by osmic acid vapour, and to examine both the surfaces of the cover-glass and the slide, to see which presented the most perfect preparations.

* Quart. Journn. Micr. Sci., xxii. (1882) pp. 260–77.
† Ibid., pp. 255–9 (1 pl.).
‡ See this Journal, iii. (1881) pp. 229–32. § Loc. cit.
‖ See description, loc. cit.

Having made a selection, a drop of the concentrated solution of nitrate of rosanilin was deposited on the glass and allowed to remain for a few moments, and then washed off with a fine jet of distilled water. The red, pale and colourless corpuscles, with their ramifications and the most delicate fibrils of fibrine, then become visible under a high power. The preparations may be mounted dry, and will keep for a great length of time. If the process be performed as rapidly as the dexterity gained by an oft-repeated experiment will allow, it will be observed that the circular appearance of the corpuscles is perfectly preserved, and that every shade of colour may be found, from the normal red corpuscles down to the colourless Norris corpuscle, which only takes the faintest tint of pink. If, however, the glass surfaces be allowed to remain in contact for a moment, the colourless corpuscles are found to have lost their globular form, and to have become pyriform or elongated. On leaving the glass surfaces still longer in contact, these pale corpuscles are observed to undergo a remarkable change. They send out long processes or tails, which bifurcate and divaricate in every direction. On allowing a still longer interval to elapse, so that it is more than probable that coagulation would occur in a film of blood lying between two glass surfaces, and on separating these surfaces, perfect specimens of fibrine may be obtained after staining. On now searching the field, the pale corpuscles, which could formerly almost always be discovered, are nowhere to be found, and the conclusion is forced upon one that the branching corpuscles have developed or broken down in fibrinous threads. Small granules are, however, found from which threads of fibrine appear to spring. These granules are described in Ranvier's 'Traité Technique d'Histologie' as the centres of fibrine formation. They appear to the author to be all that is left of the pale corpuscles, whose intermediate transformations have not before been recognized, but may perhaps be identified with the appearances and changes described. Amongst other figures, one is given showing the departure of the fibrils of fibrine from the pale corpuscles.

New Blood-corpuscle.*—According to G. Bizzozero, if the circulating blood in the small vessels of the mesentery of chloralized rabbits or guinea-pigs is observed under a high power, there will be seen, besides the ordinary red and white cells, a third form of corpuscle which is colourless, round or oval, and from one-half to one-third the size of the red corpuscle. He considers that they have hitherto escaped the notice of observers (1) owing to their translucency and want of colour; (2) because they are less numerous than the red, and less visible than the white corpuscles; (3) owing to the great difficulty of observing the circulating blood in the small vessels of the warm-blooded animals. They can be seen also in freshly drawn blood, for the most part aggregated around the white corpuscles, or immediately under the cover-glass, to which they adhere. They soon become granular, and give rise to what is called the granule-masses. Through appropriate reagents their form can be preserved.

* Arch. Ital. de Biol., i. (1882) pp. 1–4; cf. 'The Microscope,' ii. (1882) pp. 59–60.

A solution of salt coloured with methyl-violet has this property. The best method of examining them in the human subject is to place a drop of the above coloured solution over the puncture and mix the drop of blood thoroughly with it.

Owing to their typical forms, it is very unlikely that they are derived from the red corpuscles. The colourless corpuscles contain no ingredients from which they could be derived. After bleeding, and in many diseased conditions, they are increased in numbers. They play an important part in the formation of thrombi and the coagulation of the blood, which has been attributed by Mantegazza and Schmidt to the white corpuscles, because the latter are few in number in the circulating blood, and their destruction was never observed by Bizzozero, provided the blood was mixed with a saline solution. Again, the time at which coagulation sets in corresponds very closely to the time that these new corpuscles undergo degeneration. The fluids which retard or prevent coagulation—as solutions of carbonate of soda and sulphate of magnesia—have the same action in preventing the granular degeneration of these corpuscles. An indifferent solution of salt does not preserve them, but one to which the methyl-violet has been added does.

From this evidence it appears (to the editor of the 'Cincinnati Medical News') highly probable that the formation of fibrine takes place under the direct influence of these corpuscles. To them Bizzozero gives the name of "Blutplattchen."

Life and Death in the Animal Organism.*—After completing an important investigation on the "Earliest developmental operations in the ovum, on cell-division, and on conjugation in the Infusoria," O. Bütschli, early in 1876, wrote an essay headed "Thoughts on Life and Death," but he left it unpublished, considering, on the one hand, that his ideas on the differences between Protozoa and Metazoa in respect of the phenomena of death were too recently acquired to be made known, especially in print, and that, on the other hand, the speculations which he had associated with these ideas were too immature to be made permanent. His fundamental views, however, namely those relating to the non-existence of individual death in the Protozoa, have now been published.

"If we glance over the phenomena of the origin and destruction of beings in the great series of animal organisms, we are astonished by a significant contrast in the importance of individuality in the higher, i. e. the many-celled, as compared with the lower, i. e. the unicellular, forms, the Infusoria or Rhizopoda. Whilst in the first the individual, in almost all cases, asserts an existence definite and distinct even from its progeny, in the unicellular forms, on the contrary, which reproduce by fission, we are met with the fact (which does not usually receive much attention) that at the time of reproduction the individual, as such, ceases to exist, and divides its individuality equally between the individualities of its two offspring, which now come into existence. This remarkable phenomenon

* Zool. Anzeig., v. (1882) pp. 64–7. Cf. Naturforscher, xv. (1882) pp. 125–6.

appears in the most striking light when we endeavour to realize in these lower forms the idea of death, such as we have been led to consider it from observations of the higher animals. Death in the higher organisms is not the total extinction of life, but only of the individual existence; but the reproduction of a unicellular organism constitutes at the same time its death. On the other hand, however, by the idea of death in the higher organisms is implied an actual separation of organized substance from the activity of life, in other words, an annihilation of previous life. This element is entirely wanting in the individual death of the Protozoa, that is, in its reproduction; it goes on living all the same, though in the persons of its progeny.

If we study the development of certain Protozoa,—the Infusoria,—we come upon the highly remarkable fact that death does not occur in them, in the sense of annihilation of organic material and from causes inherent in the organism itself. Although these organisms, in the course of their life, are threatened by death under a thousand forms, yet this takes place by "accidents," and thus the few individuals which reproduce the species are to be considered of equal importance with the multitude which perish, for the few reproduce by fission only, and are thus immortal; while the many which die could have reproduced their species just as well as the others, if they had had the same favourable opportunity; not one of them necessarily carries in it the seeds of death.

Whoever wishes to construct a hypothetical representation of the fact that in the higher animals the individual is limited in its duration to a certain time, will find a tolerably simple plan open to him. If we hold it to be allowable to consider the peculiar vital manifestations of the cell, the fundamental element of every form of organization, as caused by the presence of a substance which acts in a certain sense like a ferment,—necessary to the production of those chemical changes in the cell which result in vital manifestations, but gradually, though perhaps slowly, used up,—then the limited duration of the life of one of the higher animals may be intelligibly represented by assuming that the ovum out of which this organism once originated acquired a certain amount of this ferment-like substance, which is gradually exhausted during life, and with the final exhaustion of which the end of the individual existence coincides.

It is otherwise with the Protozoa, which reproduce by simple division. These organisms have also this characteristic vital ferment, but they also enjoy the peculiarity of being able to renew it; hence it is not exhausted in them, and they are not overcome by death in consequence of its being used up.

But the power of forming this vital ferment is shared by the higher organisms as well, but here it is localized, being confined to the generative organs. In the other cells composing the body the material we have been speaking of is gradually and increasingly used up in the course of their active existence; but in the generative regions, whose cells maintain their primitive character longest, fresh vital ferment is accumulated for their posterity. Certain appearances occur which, perhaps, justify us in forming an approximate idea as

to the place in the cell which this material with its property of evoking life occupies. Among these the chief are the phenomena of conjugation of Infusoria, taken in connection with facts recently acquired in the study of the process of fertilization in the Metazoa. The gradually diminishing vital energies of the Infusoria are strengthened afresh by conjugation, and this comes about by a partial or total renewal of the nucleus from the so-called nucleoli or primary nuclei. A total or partial renewal of the nucleus of the ovum is also seen in fertilization, and it is most probably effected by the spermatic nucleus.

(This passage was written in 1876, when the first and imperfect account of the process of fertilization had just been put forth; but it would be easy to alter it so as to bring it into accordance with our present knowledge, without interfering with the part played by the nucleus.)

Thus the failing vital powers of the Infusoria are raised up again by the renewal of the nucleus, and a similar result occurs in the process of fertilization; is it not, therefore, a justifiable conclusion that the vital ferment which has been spoken of, actually resides in the nucleus of the cell, whenever this is present. It is not the whole nucleus which is to be interpreted in this way, but only a small part of its bulk. Thus in the case of the Infusoria, it must be assumed that the freshly produced life-ferment is collected more especially in the so-called nucleoli, but in higher organisms in the reproductive cells, chiefly in the nucleus of the male reproductive elements."

N. Cholodkowsky, in discussing * the doctrine of Bütschli, points out certain difficulties in the way of our accepting this view. Some forms, e. g. *Hydra*, have an asexual as well as a sexual method of reproduction; now, if all the cells of such an animal have the power of producing new individuals they must all be immortal; yet, as a matter of fact, we know that many die down. It seems to Cholodkowsky that the cause of the death of the Metazoa is to be sought for in the multicellularity of their organism. A cell has in itself and for itself a potential immortality; but as soon as differentiated cells are united into an individual there commences amongst them a struggle for existence, which, *eo ipso*, leads to destruction. The hypothesis of Bütschli recalls the Darwinian doctrine of Pangenesis; just as Darwin supposed a general distribution of reproductive cells throughout the organism, which only later became concentrated in the generative cells, so does Bütschli deal with his vital ferment, and the doctrine of the latter is therefore only a more physiological way of expressing that of Pangenesis.

Pelagic and Deep-Sea Fauna.† — T. Fuchs enumerates the distinguishing characteristics of the pelagic and the deep faunas respectively, and makes some inductions as to the reasons for these peculiarities. Pelagic animals are those which are wholly independent of the shore and the sea-bottom at all stages of their existence.

* Zool. Anzeig., v. (1882) pp. 264–5.

† Verh. k. k. Geol. Reichsanstalt, 1882, pp. 49 and 55. Cf. Naturforscher, xv. (1882) pp. 199–202.

Most of them are transparent and colourless, and thus invisible in water; where colour occurs, it is usually violet or blue, resembling that of the water; the fishes are chiefly steel-blue above, silvery-white below. Most forms are naked; the shell, if present, is comparatively delicate. A large number are viviparous, even when their nearest allies are oviparous.

A great number of pelagic animals are phosphorescent. Nearly all are admirable swimmers. Some have their surface-area largely developed, e. g. the tests of Radiolaria, of *Globigerina*, *Hastigerina*, &c., probably in order to hinder sinking. As to the manner of life, they are almost without exception social, they mostly have a very wide distribution, and are found alike in the Atlantic, Indian, and Pacific Oceans; the genera are almost all identical in these seas, although polar seas are distinguished from warmer waters by possessing few forms besides Crustacea, Pteropoda, Cephalopoda, and Cetacea. In connection with their usually delicate structure stands the fact that it is only in the calmest weather that they live on the surface; storms may drive them to a depth of more than 50 fathoms. Further, far the majority only come to the surface in the night, a point to be considered in connection with the prevalence among them of phosphorescence; the time of appearance of the phosphorescent fish is more often connected with the night than with any other time. Pelagic animals seldom occur except over deep water, and at great distances from coasts, hence their scarcity in the German Ocean, their poverty in littoral and their abundance in deep-sea deposits.

The deep-sea fauna is distinguished by the appearance or predominance of certain individual species, genera, and families, and exhibits little variation in the different parts of the world. It commences at a depth of about 50 fathoms in all seas, but it is only in the tropics that anything like a sharp line of demarcation is found between it and the littoral fauna. Examining these points to ascertain the reason for a bathymetric limit of this particular nature, Fuchs finds that it cannot be due to temperature, although this diminishes as the depth increases, for in the Red Sea the warm zone extends much below 50 fathoms, while in polar waters even the surface has a low temperature, and currents operate besides so as to introduce great irregularity into the bathymetric relations of temperature; however, the fact that 43 to 50 fathoms has been ascertained to be the limit to the penetration of light into the sea appears to him good evidence that the presence or absence of light is the determining agency sought for, and that the littoral fauna is simply the fauna of the light, the deep-sea fauna that of darkness. This view is supported by the more superficial distribution of deep-sea forms in some places in which the limit of light lies at an inferior depth, and the deeper range of littoral forms in fresh waters, where the light has greater penetration. The large eyes or blindness of so many, the pale or monochromatic colour of most, and the phosphorescence of a large number of the animals which compose this fauna is evidently connected with the absence of light. The resemblance of the pelagic to this fauna is intelligible if it is remembered that it too is most in its element in

the darkness. Resemblances between cave faunas and that of the deep-sea point also to a common cause in the absence of light. The range of some littoral forms into great depths may perhaps be found to be due to their being nocturnal in habits.

The cavities which occur under coral reefs off Brazil may perhaps shelter a fauna of deep-sea character, owing to the absence of light there; hence it would be not unlikely that geologists might find similar aggregations of deep-sea animals in formations otherwise composed of littoral reefs. Otherwise the relations of deep and littoral faunas were probably much the same in geological times as now, owing to the similarity of their relations to the light, and the differences here indicated can, in point of fact, be traced throughout all formations.

B. INVERTEBRATA.

Mollusca.

Anatomy and Classification of the Cephalopoda.* — Dr. J. Brock commences with a study of *Rossia*, the knowledge of the anatomy of which is confined to the short description given by Prof. Owen. As a result of the new investigations we find that *Rossia* is, as has been supposed, most closely allied to *Sepiola ;* the relations of these two forms to the Myopsida, and especially *Sepia* and *Loligo*, are by no means so clear. The author's earlier investigations led him to the belief that the affinities of the different forms might be well shown by this diagram :—

Sepia.
|—Rossia———Sepiola.
|—Loligo.
|—Ommastrephes.

The presence, however, in *Rossia*, of fused lower salivary glands points to its affinities with the Œgopsida, and this would lead us to form a table in which *Loligo* should stand above *Rossia*, or nearer *Sepia*. As to the relations of *Sepiola* to the form last named, it might be supposed that *Sepiola* had branched off from the Decapod stem independently, but the Octopod characteristics of *Sepiola*, as seen in its musculature, are to be found also in *Rossia*, and it requires evidence of a kind very different from that which we have at present to lead us to believe that these very similar arrangements could have been independently developed by the two forms. The Octopod type of the musculature of *Rossia* is still further developed in *Sepiola*, and that in a way which justifies us in regarding the latter as a direct descendant of the former. A useful table is given in which are enumerated twelve characters and the respective resemblances and differences of *Ommastrephes*, *Rossia*, and *Sepiola*.

If the view that *Rossia* and *Sepiola* form a line of development which branched off from the Decapod stem shortly before *Loligo* be

* Zeitschr. f. wiss. Zool., xxxvi. (1882) pp. 543–610 (4 pls.).

correct, we find in it what may be spoken of as parallel-developments with the Myopsida and Octopoda; we find, that is, in this side branch a series of differentiations which have, for the different organs, a most remarkable resemblance in those two series. Just as from *Loligo* to *Sepia*, so from *Rossia* to *Sepiola* we find the upper salivary glands lost, the accessory nidamental glands fused, the efferent duct of the ink-bag sharply marked off, and the lateral teeth disappearing from the middle plate of the radula. From *Ommastrephes* to *Sepia*, just as from *Rossia* to *Sepiola*, the fused lower salivary glands are separated, and there appears a characteristic arrangement of the ova in the duct. Likewise, there is in *Sepia* and *Rossia* a shortening of the inner pallial nerves, which finds its termination in the absence of these in *Sepiola* on the one hand, and the Octopoda on the other. A very instructive diagrammatic table is given by the author to demonstrate the points on which he insists.

If we enter into still wider generalizations, the facts observed by the author lead us to see that in the Dibranchiate Cephalopoda, long before the separation of the phylum into the Octopoda and Decapoda, there must have been a tendency, under suitable, though still unknown, conditions, for the cartilaginous articulations with the mantle and funnel to yield to firmer membranous or muscular cephalic joints; thrice, or twice at least, did this tendency exert its influence. In connection with this there must also have been a tendency to the reduction and final loss of the upper salivary glands, the separation of the lower ones, and the fusion of the accessory nidamental glands.

Dr. Brock then passes to a second study of the generative organs of the Cephalopoda; in dealing with the female organs of the Œgopsida it is pointed out that the nidamental glands may be absent, as in *Enoploteuthis*, or that they may be present, with (α) the oviduct lying ventrally to the gills, as in *Ommastrephes sagittatus*, or (β) the oviduct may open with a buccal invagination of the integument, lying dorsally to the gills, as in *Om. todarus*, *Onychoteuthis*, or *Thysanoteuthis*.

A study of the generative organs of the Philonexidæ shows us that they may be thus arranged:—

1. Subfam. Hectocotyliferæ. ♂ with a free *Hectocotylus*.
    - *a.* Philonexidæ S. Str. Hectocotylus without dermal frills. No water-vascular system—*Argonauta*, *Philonexis*.
    - *b.* Tremoctopodidæ. Hectocotylus with dermal frills. A water-vascular system—*Tremoctopus*.
2. Subfam. Parasiridæ. Free hectocotylus not known, but probably present. ♀ with very long oviducts, viviparous. *Parasira*.

In dealing with the gland of the oviduct, it is pointed out that the following series may be detected in the Octopoda:—

1. Gland consisting of a series of cæca arranged radially around the oviduct; no increase in the extent of the secreting surfaces —*Argonauta*.
2. The secreting surfaces of the gland well developed, and a

circlet of strongly developed receptacula seminis interpolated between the gland and the oviduct—*Tremoctopus violaceus*.

3. The receptacula seminis not so well developed; a fresh gland developed between them and the primitive gland—*Parasira catenulata*.

4. No receptacula seminis; the walls of the primitive and of the secondary gland highly developed, and in the latter so far advanced as to lead to a fusion of the glandular sacs—*Octopus*, *Eledone*.

Various as are the forms of the oviducal gland in the Octopoda it is important to notice how uniform they are in the Decapoda.

The author then enters upon a consideration of the so-called water-canals and the viscero-pericardiac cavity; he finds that the genital capsule of the Octopoda is the (reduced) direct homologue of the viscero-pericardiac cavity of the Decapoda; and that the water-canals of the Octopoda correspond to the anterior, while the genital capsule corresponds to the hinder portion of the viscero-pericardiac cavity of the Decapoda. And he concludes with accounts of *Tremoctopus ocellatus* n. sp., *Octopus pictus* n. sp., *Loligo bleekeri*, and *Cranchia reinhardti*.

Ink-Sac of Cephalopoda.*—P. Girod publishes a full and detailed account of his study of this organ.† By a careful dissection, first of the peripheral trabeculæ, and then of the apex of the pyramid formed by the formative zone, we come upon the cellular mass which forms the central portion of the trabeculæ. When a portion of the tissue of this part is teased out, elongated cylindrical cells may be detected which, in their general character, are not unlike the cylindrical cells of many mucous membranes; the large nucleus which occupies the narrower end of the cell becomes very apparent on the addition of colouring reagents. The cell itself, on high magnification, is found to be divisible into two portions: the larger of these is coloured yellow by picrocarmine, and seems to be formed of a hyaline liquid, which is limited on the nuclear side by a faint, slightly concave, and granular line; the second and narrower portion contains a granular protoplasm. The constitution of the cell suggested to the author that it belonged to the calyciform series, but the absence of any orifice did not seem to him to justify that view. Near these cells others may be seen which contain black granulations in their upper portion; these are not cylindrical, but are divided by constrictions into three portions; the uppermost colouring matter is bounded externally by the cell-membrane, and is also distinctly separated from the nucleus. On the whole, there is a very close connection between these and the cells of the first set, the hyaline mass in the latter being now filled with pigmented granulations, and the part which contains the nucleus having been elongated. Other cells present other characters; in some there is a much larger aggregation of pigment, whence two lateral prolongations descend, one on either side of the nucleus: here, too, slight pigmented granu-

* Arch. Zool. Expér. et Gén., x. (1882) pp. 1–100 (5 pls.).

† See this Journal, i. (1881) pp. 227, 586, and 876.

lations are to be seen within the substance of the nucleus. In others the black granulations are so richly developed as to completely obscure the nuclear mass, although that body is still present. Finally the cells commence to undergo degeneration, their membrane breaks, and the pigment escapes; the nucleus, however, still persists, and it is in consequence of this that we find free nucleated masses in the midst of the pigmented granulations. The author discusses in order the histological characters of the meshwork, the wall of the pouch, its internal, median, and external tunics.

Turning to the development of the ink-sac, we find that on the fourth day of the second period (that of the development of the organs) the anal depression comes in contact with a process of the mesoderm, and then divides into two portions, the superior of which is the ink-sac, and the inferior the rectum. The former rudiment has at first a transverse direction, and extends from the anal orifice to the internal yolk-sac, and is clothed by a single layer of epithelial (ectodermic) cells. This is what will form the vesicle. The cells at the cæcal extremity soon begin to multiply and form a thickening which is the rudiment of the gland. The glandular mass developes rapidly by making its way into the midst of the mesoderm; the cells of that layer now begin to form peripheral layers around the gland, till they nearly completely surround it, and the mass becomes divided into two lobes, between which there is an extension of the mesoderm. Changes in the cells themselves now appear, and give rise to the formation of a thick granular liquid. As soon as the glandular cavities are developed the investing cells take on the characters which belong to the formative zone of the adult, and a peripheral and a formative zone are thus developed. Further changes bring about a connection between the gland and the reservoir; the latter then begins to increase rapidly in length, and at the same time to dilate. Still further changes, in the mesoderm, give rise to the different investing layers, and there is some alteration in position. Looking more generally at the matter, we find that the ink-sac is formed by an epidermal invagination, which, during development, is differentiated into two parts, the gland and the vesicle (reservoir); this invagination is contained in a kind of mesodermic sac, which forms the tunics that envelope the epithelium; the innermost of these consists of an epithelial and of a connective layer, the median of the silvery and of a muscular layer, and the outer of connective tissue. When we compare this with the integument, we cannot but be struck with the remarkable similarity between them; there, too, we find an epithelium, the cells of which are arranged in a single row, and limited externally by a thick cuticle; the connective layer contains the chromatophores, and beneath this there are a silvery layer, muscular fibres, and a layer of connective tissue. The absence of chromatophores in the region of the sac may be explained by a study of the intermediate stages presented by different parts of the body.

The researches of Lacaze-Duthiers on the purple-glands of certain Gastropoda have led the author to make a study of these structures, from which it results that their anal gland is homologous with the

ink-sac of the Cephalopoda, and this view is strengthened by a consideration of the nervous supply. In the Gastropoda the glands in question receive filaments from the "asymmetrical centre," in the Cephalopoda the nerves come from the visceral or inferior ganglion which corresponds exactly with that centre.

If we compare the ink-sac of the Octopoda with that of the Decapoda we find that there is in the former an arrest of development, the reservoir not being elongated or widened out; in consequence of this close relations still obtain between it and the anal orifice, and the gland and reservoir are closely applied to one another. It is to be borne in mind that the tetrabranchiate Cephalopoda are without the organ, and that it is only some of the Gastropoda which possess one, and that that one is always much simpler in character.

The physiology of the question is also dealt with, and it is pointed out that three stages may be distinguished in the excretion of the ink: (1) there is a continuous passage of ink from the gland into the vesicle—due to a *vis a tergo*, and to the compression exercised by the limiting membrane of the gland and the nodosity of the vesicle; (2) an intermittent passage of the ink from the vesicle into the sac, due to the contraction of the vesicle; (3) spasmodic expulsion of the ink by the funnel, due to the spasm of expiration. The nerve-branches from the visceral nerves were found to be motor filaments, presiding over the contraction of the wall of the vesicle.

Sense of Colour in Cephalopoda.*—How highly developed the sense of colour is in insects has been shown by Sir John Lubbock in his interesting observations on bees, wasps, and ants. For the development of the same sense in animals of a different type C. Keller brings forward evidence taken from the cuttle-fishes, which manifest in a high degree the power of adapting the colour of their skin to that of the environment. Keller was able to observe this adaptation of colour in *Eledone*. In the Naples Aquarium a specimen of this Octopod was under the necessity of flying from a powerful lobster; during its flight it appeared pale red; but subsequently, resting on a tuft of yellow rock covered with brown spots, it imitated the yellow ground-colour with its brown spots so closely that it became almost invisible to the observer. In this case the conditions were decidedly very favourable for the occurrence, for yellow and dark-brown colour-cells occur in *Eledone* in large numbers. It should be added that the eye of the cuttle-fish shows an unusually high development.

'Foot' of certain Terrestrial Gastropoda.†—Mr. J. Wood-Mason describes the structure of the part of the foot called by German writers on malacology the *Fuss-saum* which, as no technical name for it appears to exist in the English language, he proposes to call the *peripodium*, in allusion to its relation of position to the locomotor ventral surface or foot of the molluscs possessing it, but which he thinks may be homologous with the lateral folds (epipodia)

* Vierteljahresschr. Naturf. Gesell. Zurich, xxvi. (1881) p. 100. Cf. Naturforscher, xv. (1882) p. 40.

† Proc. Asiatic Soc. Bengal, 1882, pp. 60–2.

of many marine molluscs (*Haliotis*, e. g.). Very frequently the peripodium is provided at its posterior extremity with a capacious pit, the capacity of which may be increased by the prolongation upwards of its anterior margin in the form of a horn, which not being specially sensitive is not a tentacle, often it is without this terminal pit; it is invariably richly ciliated throughout from the mouth on one side round to the mouth again on the other side dorsally; equally invariably is it limited off from the side of the body (and frequently also from the muscular foot) by a peripheral groove, which deepens anteriorly. Its office is to assist in lubricating the foot, the pit when present receiving the effete lubricating fluid and throwing it off in gelatinous lumps.

The foot-gland, as is well known, pours out its abundantly and constantly flowing secretion through an aperture which is situated below and a little behind the mouth into a hollow whence it naturally falls into the deep anterior end of the dorsal peripheral groove, whence again it is carried by the cilia with which the surface of the peripodium is beset (being distributed to the foot as it goes) to the terminal pit. In those forms in which this pit does not exist, the secretion that has served for lubrication is merely left behind by the crawling mollusc.

As Pulmonata possessing a ciliated peripodium with and without a terminal pit are to be found in every quarter of the globe, and as it is in the highest degree improbable that so highly specialized a structure, subserving such an important purpose in the animal economy as this evidently does, has arisen independently many times in many different forms in many widely separated areas of the earth's surface, the author considers that it has a higher taxonomic value than has hitherto been assigned to it, and he feels strongly inclined to distinguish those forms that possess it and those that do not (or have lost it) from one another by calling them Craspedophora and Lipocraspeda respectively.

Mucin of Helix pomatia.*—According to H. A. Landwehr, when the mucin of *Helix pomatia* is treated with 1 per cent. sulphuric acid, it yields grape-sugar, whereas mucin from other sources yields only a reducing substance. The grape-sugar cannot be derived from glycogen, since the iodine reaction fails entirely in the freshly expressed secretion, and in the mucin prepared from it. The author however, succeeded in obtaining a carbohydrate, for which he proposes the name "achrooglycogen." In order to prepare it, he directs that the mucin obtained from the snails shall be treated with 5 to 10 per cent. caustic potash, and the proteïds separated by Brücke's solution (potassiomercuric iodide), the solution filtered, and the filtrate precipitated by alcohol. The material thus obtained, after being washed with absolute alcohol and dried, is an amorphous, white, tasteless powder, readily soluble in water. The solution is strongly opalescent, gives no iodine reaction, and does not reduce an alkaline copper

* Zeitschr. f. Physiol. Chem., vi. (1882) pp. 74–8. Cf. Journ. Chem. Soc. Abstr., xlii. (1882) p. 708.

solution. By boiling with acids, or by digestion with saliva or diastase, the substance is converted into dextrin and grape-sugar.

Rhodope veranii.*—Professor L. Graff gives an account of this form, which was regarded by Schultze as a Turbellarian, and named *Sidonia elegans;* he has been able to demonstrate that it is not a worm, but the Nudibranch long ago described by Kölliker under the name of *Rhodope veranii.* The largest examples are about 4 mm. long, with a breadth of $\frac{1}{3}$ mm.

The integument consists of a single stratum of cylindrical epithelial cells, and is pretty closely invested by long cilia; this integument is pigmented, and a figure of the curious arrangement of the colour, under what the author regards as its typical form, is given. Calcareous spicules, of some size, are to be found under two different forms, embedded in the parenchyma of the body. The mouth lies at the anterior end, but is sometimes held dorsally; the cavity into which it leads is provided with closely appressed small papillæ, but there is no indication of anything like a radula. After some account of the other parts of the digestive system, of the nervous system, and of the generative apparatus, Dr. Graff states that, like Kölliker, he searched in vain for any indication of a heart or blood-vessels. The numerous small oval corpuscles which fill the cœlom were suspended in a colourless fluid, which appears to be set in motion by the movements of the body, or the contractions of the enteron. The author was, however, enabled to discover a water-vascular system similar to that of the Platyhelminthes. Strong magnification revealed actively moving flagella, scattered through the body, and similar to those which are found in the excretory system of various Vermes. Each flagellum is continued in a vesicular enlargement, and by its widened base completely closes the ciliated funnel, the free end of the flagellum being directed towards the efferent canal. No exact information can be given as to the branchings of the excretory system, or as to the character of its orifices.

The absence of gills, buccal mass, and radula, as well as of a vascular system, proclaims *Rhodope* to be the very lowest of all known Nudibranchs; at the same time it is distinguished from the allied Turbellaria by its anus, by the structure of its generative organs, its central ganglia, and its sensory apparatus. *Rhodope* must not, however, be supposed to have been derived from the present specialized Dendrocœla, but from a group of Rhabdocœlida, to which, in his forthcoming Monograph of the Turbellaria, the author intends to apply the term Alloiocœla; this group will contain *Vorticeros* and others, and will be distinguished from the Acœla and the true Rhabdocœla by characters which will, we think, be better understood when that subject comes before us.

Molluscoida.

Test-Cells in Ascidian Ova.†—These cells, so characteristic of the ova of Tunicates, obtained their name from the belief that they

* Morph. Jahrbuch, viii. (1882) pp. 73–83 (1 pl.).
† Zool. Anzeig., v. (1882) pp. 356–7.

eventually formed the test enveloping the Ascidian. This view was shown to be erroneous, and Professor J. P. McMurrich now enunciates a new theory as to their function.*

The latest theories on the subject of parthenogenesis and of the nature of polar-globules are based on the assumption of the bisexual nature of the ovum, on account of which it is possible, and there is even a tendency, for a yolk to divide spontaneously. In most cases this is disadvantageous, and the formation of "test-cells" is a means of guarding against the misfortune. On the exposure of the ova to sea-water or other abnormal condition a contraction of the yolk is brought about, and thereby a tension upon the nucleus, which, under the strain to which it is subjected, would divide, and so start the process of segmentation, were that strain not removed from it by the extrusion of the test-cells, whereby it is preserved intact until the proper stimulus in the shape of a spermatozoon excites it to a healthy and normal division.

This theory the author would also suggest as an explanation of the *Excretkörper* described by Hertwig and Oellacher as appearing in the ova of Amphibia and fish respectively, and also of the fatty globules described by the late Sir Wyville Thomson as occurring in the eggs of *Comatula*, to which structures test-cells bear no little resemblance.

Embryology of the Bryozoa.†—J. Barrois finds that the larva of a Bryozoon consists essentially of five principal parts; an aboral surface, the peripheral part of the oral surface with the corona which is only the edge of it, the incubating pouch with the central part of the oral surface which is destined to form the intra-tentacular space, the intestine, and lastly, the rudiment of the polypite which already exists in the larva, where it forms a special organ, and takes more or less a part in the formation of the polypite.

In the Entoprocta these parts have most nearly the arrangement which is found in the adult; the aboral surface forms the integument of the larva, and the oral is retractile and can be withdrawn into the vestibule; the only change necessary to convert the larva into the adult is a rotation of the incubatory pouch and the intestine so as to bring them into relation with the rudiment of the polypite. In the Chilostomata there is developed, by the aboral growth of the corona, a pallial cavity;—as the oral surface has here lost its retractile power, there must be a change in the position of the mantle before the larva can pass into the adult condition; here, therefore, there is a more marked metamorphosis. In the Ctenostomata the pallial cavity is enormous, and the cells of the corona are of very large size; in the Cyclostomata there is no corona, but the oral surface continues to grow towards the aboral pole; and here, therefore, we have, in its most marked condition, the process which has become more and more

* In a previous paper he showed that the test-cells were produced by a contraction of the yolk of the ovum, consequent on the action of various stimuli being formed, more or less distinctly according as the stimulus was capable of causing a greater or less contraction of the egg-contents.

† Journ. Anat. et Physiol. (Robin) xviii. (1882) pp. 124–61 (1 pl.).

marked the further we are removed from the Entoprocta; in consequence of this the oral surface, which was at first entirely enclosed in the interior of a cavity (the vestibule) and covered over by the aboral surface, has gradually passed more and more to the exterior so as to form by itself the external integument and to drive the aboral surface into the interior of a cavity (the pallial cavity). In the most differentiated types of the Chilostomata and Ctenostomata we have seen that the aboral surface has been driven into the interior; notwithstanding this, the uppermost portion of this surface which forms the organ called the "calotte" has always been seen to be projecting. In the Cyclostomata, however, the pallial cavity is always closed and covered over. Adding to these the Lophopoda, we may make the following table:

Entoprocta	Predominance of the aboral surface. Vestibule at its maximum. Intestine well developed.
Chilostomata and Ctenostomata (sac reduced)	Predominance of the corona. A pallial cavity. The intestine reduced to a mass of globules.
Cyclostomata and Lophopoda (no sac).	Predominance of the oral surface. Pallial cavity at its maximum. Intestine disappeared.

The author points out that from the point of view of larval forms only we seem to find an essential character in the antagonism of the two great cavities at the poles, and, when we carry this further, in the greater or less development of the mantle. It is according to the extension of this last that we find one or other of the two surfaces of the larva best developed; when there is a median extension of the mantle we find, moreover, that the intestine has partly disappeared; while when it is at its maximum condition of extension there is no intestine at all. When we come to look at the matter in a more general way we see that this development of the mantle is not a matter of so great importance, inasmuch as every form of larva, no matter to what type it belongs, can always be referred to a common type, in which there is no mantle, in which the oral surface is always within the vestibule, and the aboral forms an integument. The history of the mantle is, then, only a history of a series of adaptive modifications.

Dealing with the mechanism of the metamorphosis, M. Barrois finds that if we try to construct a general type of adult Bryozoon we have to recognize (1) a foot corresponding to the oral pole, (2) the frontal surface, corresponding to that which answers to the oral, and (3) a tergal or anal surface. In the Entoprocta these can be easily made out, but in the Ectoprocta it is not always so distinct; in the forms where the zoœcium is elongated we seem to have the primitive disposition, in the flattened ones the tergal surface is increased in extent; palingenesis is to be seen in the Ectoprocta, cœnogenesis in the Entoprocta.

As the author regards the Bryozoa as belonging to the Vermes he notes that, with the exception of the Rotifera, the Bryozoa are the only Vermes in which a telostomiate condition is constantly manifested, either in the larval or in the adult condition; in other words, the division of the body is on the primitive or gastrula

type, in which we see an oral and an aboral pole. A free-swimming Entoproctous larva is then formed on the same type as a Rotifer. Granting this, we must suppose that the Bryozoon is the result of a simple change of life; we know that these larvæ often creep about on their oral surface. If this habit were to become permanent we should have in the change of habits a sufficient cause for the metamorphosis; the ciliary current carrying food to the mouth would, on passing it, abut against the anal extremity of the vestibule, and would gradually drive this back towards the superior extremity of the larva; there would thus be produced the rotation, in which the digestive tube would be implicated. We may assume the earlier existence of a group of Probryozoa, free-swimming creatures, of a general Rotifer-form, only represented to-day by the larvæ of some of the Entoprocta; these on taking to creeping would have their form altered by a current of water.

New Adriatic Bryozoa.*—Dr. Piesser discovered in some material sent him from Rovigno in the Adriatic a Bryozoon, which he found difficult to determine on account of its having some of the characters of *Gemellaria* and some of *Notamia*, but he calls it *Gemellaria*, and considers that the definition of the genus must be widened to receive it.

It consists of rows of double cells back to back, and the aperture occupies most of the front. A zoœcium does not spring immediately from the zoœcium below as in *Gemellaria loricata*, but grows in the manner of *Notamia bursaria;* further, at the commencement of each branch instead of a pair of zoœcia, there is only one, out of which a pair grow. There are radicle fibres which start from the back of a pair of cells and grow out independently, instead of uniting together and growing in a bundle down the dorsal surface of the colony.

The most perplexing point to Dr. Piesser was the occurrence of avicularia at the top of the zoœcia, sometimes sessile and very minute, at others they are much larger and pedunculate. He thinks that these characters show that it is a connecting link between *Gemellaria* and *Notamia*, and if his interpretation is correct, about which opinions may perhaps vary, we may look upon this as another instance showing that the presence or absence of avicularia cannot often be relied upon for generic division. It may interest Dr. Piesser to know that although this curious species has not previously been described, yet it lives in the Bay of Naples, and has also been found from a locality outside the Mediterranean.

Arthropoda.

α. Insecta.

Sensations of Sight conveyed by the Facet-eye.†—The experiments of Grenacher, Dor, and Exner, as to where the rays received by the compound eye of Insects ought to be and are concentrated, led to the most contradictory results, until Grenacher finally established the true view. Several points, however, as to the quality of the

* Neunter Jahresber. Westfälisch. Provinzial. Vereins für Wiss. u. Kunst, 1881.

† Abh. Senckenberg. Naturf. Ges., xii. (1880) pp. 35–123 (3 pls.).

function of vision still required investigation. The close parallel with the Vertebrate eye which was attempted to be drawn, is quite fallacious. Clearness of sight was said by Joh. Müller to coincide with long sight, and to be best exhibited in those eyes which have the greatest circumference—the greatest number of very small facets, large crystalline cones and dark pigment-mass; the nearer the object to the eye, he said, the clearer the view obtained of it.

Dr. J. Notthaft believes the size of the facets and the length of the radius of the curve of the eye to be the only factors in its structure which have an important bearing on this point. With regard to the effect produced by the presence of a number of receptive and refractive units—the units of the compound eye—he believes that the edges of the units and fields of sight are in contact; when the curve of the eye is perfectly spherical the fields are approximately polyhedric, like the facets, but when the curve is eccentric, distortion appears as magnification increases. The smallest angle of sight is constituted by the angular distances between the directions in which two neighbouring retinal elements look, or even between two such ocular elements regarded as wholes. A few examples may be given of the actual condition of things in some specific eyes:—

	Difference of direction between two terminal elements.	No. of Facets.	Smallest Angle of Vision.	Breadth of Facets.	Radius of Curve of Eye.	Distance at which the Sight-field of a unit = 1 cm.
				mm.	mm.	
Apis mellifica ..	104°	54	1° 56′ (or 0° 51′)*	·024	{1·62; 0·75}	67 cm.
Formica rufa (worker)	51°	35	1° 27′			
Sphinx convolvuli	67°	39	1° 43′			
Acherontia atropos	20°	13	1° 32′ (or 0° 42′)*	·037	3·0	81 cm.

* Determined by calculation from the radius of the eye-sphere as compared with the breadth of a facet.

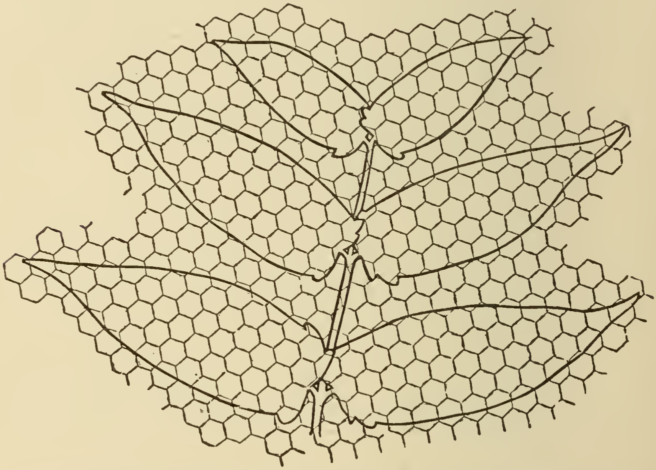
In spite of its large minimum angle of vision, the insect eye affords, under certain circumstances, as great an amount of distinctness of vision as the human eye, or even greater; for there is no minimum limit to the distance of vision, and objects near the eye are seen more clearly than anywhere else; the distinctness of vision diminishes as the square of the distance from the eye: these relations for the following insects are:—

	Distance in mm. at which the Clearness		Amount of Clearness with a Distance of	
	= 1.	= 0·1.	0.	60 cm.
Apis mellifica	1·35	7·77	3·36	0·000024
Sphinx nerii	0·81	8·51	1·67	0·000035

The indistinctness produced by distance has the effect of reducing the image of (e.g.) an *Ailanthus* leaf to an outline in which the different lobes are almost entirely merged together, and almost all the detail lost (cf. Figs. 88 and 89).

Exner's view of the impression produced on the insect eye of the degree of rapidity of movement in any objects, viz. that it is inti-

Fig. 88.



Leaf of *Ailanthus glandulosa*, showing part taken by the different portions of the compound eye in viewing it.

Fig. 89.

Effect produced on the retina by the leaf thus viewed.

mately connected with the movement of the insect itself, must lead to absurd conclusions. Joh. Müller's view, that insects see objects only by means of the accurate perception of their illumination, is the most important point in the theory of mosaic sight (that of

compound eyes), and contains the key to its principle. Only those rays of light can affect the eye which fall on it in the radial direction, i. e. in the direction of the long axes of the crystalline cones. Each retinula (retina of a single unit) receives a cylindrical bundle of light-rays from every visible object; exactly the same amount of an object is taken in, at whatever distance it is viewed, so the effect of motion is not produced by an increase in or reduction of the amount which is seen of a moving body.

The action of direct sunlight on insects is evidently, from their sensitiveness to it, of great importance to them. Seeing that the angle which the rays proceeding from the orb of the sun make on reaching the earth is on the average 32′, the smallest angle of vision for a unit of any insect's eye being probably more than 10′ (39′ is the lowest known to the author, viz. in an *Æschna*), the single image of the sun would be spread, at the most, over three unit-eyes, and, at the least, over one; while the minute unit of the human eye, having an angular distance of 10″ only, can take in $\frac{1}{192}$ of the sun's disk, and thus the disk occupies in the retina a surface 192 units in diameter, and covering about 27,000 rods. The amount of light which can be received directly by the facetted eye from the sun is far less than that received by the human eye, in fact only from $\frac{1}{9000}$ to $\frac{1}{27000}$ of the amount received in the latter case. The bearing of this striking fact on the habits of the insect is difficult to see, but it may be asserted that the insect's eye is thus well provided against the effects of a too intense light, while its sensibility to minute grades of illumination from terrestrial objects remains incontestably one of its most important properties. For by far the greater amount of the impinging light is absorbed by the epidermic structures, and owing to the spherical curvature of the eye, the rays which reach it coincide in direction with the optical axes of but a few of the units, and so but a small portion of the receptive nervous region is affected by them; thus only the $\frac{27}{1000000}$ part of the sun's disk is perceived by a single eye. This view is supported by Grenacher's opinion that it is the median (i. e. direct and unrefracted) rays of the pencil which strike a facet, which are the most important. The perception of an object in all its dimensions and of its relation to surrounding bodies cannot be *learned*, as it is to some extent in our own case, during the short life of the insect. Some idea of the character of the insect's vision may be gained from the observed fact that the natural impulse of the insect is to court the darkness (e. g. the lower sides of leaves, the shade of grass, &c.), in order to avoid observation; their well-known delight in brilliant illumination forming merely an episode in their life of caution. Probably they are to some extent subject to optical delusion; thus when the sun suddenly goes behind the clouds, the surrounding objects, before so brilliantly illuminated, would appear to be at a greater distance, owing to their loss of light. To ascertain the relations of objects with regard to the surrounding space is the most important function of this organ in these animals, and especially the relation of distance from the eye itself; these ends are attained by the comparatively large angular distance which

the closely apposed elements present. The actual distinctness of the features of the object is less important here than with the human eye.

The reason for the existence of two forms of eye, simple and compound, in perfect insects, is that of separating the impressions of space and distance from those of distinct sight of the object (the latter end being attained by the stemmata or simple eyes). Four, on the whole strongly distinct, kinds of vision are differentiated in the animal kingdom:—

1. General sensation of the *amount of light* evolved in the environment and of the relative position of its source; analogous to our sensation of warmth, and exhibited only in small organisms with transparent outer coverings, and devoid of special portions of the body adapted for the function. 2. Sensitiveness to colour and shades of colour; general orientation as to environment, power of recognizing known objects—the "eye-spots" of Vermes, &c. 3. Information as to relative positions of surrounding objects affording guidance of movements, with slight amount of guidance as to characters of object—compound eye of *Arthropoda*. 4. The most clear and faithful perception of the objects, the images reversed by a lens which strongly refracts light. The contents of a *plane* are the subject of this kind of vision, which does not convey to the brain the distance or mutual relations of objects; the plane may be either single, at a constant distance from the eye, or there may be several at distances which vary within certain limits, as when *accommodation* comes into play. In this case the third dimension, viz. depth or distance of objects, is obtained by movements made by the eye-bearing individual, relatively to the objects viewed, materially aided by the power of accommodation, when this is present; in its absence, as in the case of the *stemmata* of Arthropoda, this impression must be very feeble, since the moving animal obtains nothing but a disconnected series of images of the objects as they come one by one within the range of its organs.

The phylogeny of the compound eye is deducible from the fact of the acquired character of the movements of Arthropoda; as the faculty of motion became better developed, the organs of sight became modified, *pari passu*, into that form which successfully met the requirements of this mode of motion, in the manner above explained; the highest degree of development being naturally reached in the Insecta. All winged insects are thus provided, while but few of the wingless forms, such as larvæ, &c., have this form of eye.

The explanation of the peculiar character of the vision enjoyed by the compound eye lies in the lenticular curvature of the corneal facets, which do not act as Joh. Müller supposes, by magnifying the entering rays, but by admitting only those which are not likely to prove injurious; this appears to be shown by a comparison of the Insect with the Crustacean eye. The latter is remarkable (judging by the results obtained by Grenacher from *Mysis*) for its large angle of vision—3° 16′ in the instance taken—and is probably fitted to convey impressions from a distance not exceeding a metre. Taking into

consideration the density and other light-absorbing properties of the medium in which the insects live, the amount of light received from an object must vary approximately as the cube of the distance of the source of light, hence the wide opening of the eye, admitting as much light as possible. The same effect as the perspective which is obtained in air is here produced by the indistinctness of objects, owing to the opacity of the medium, in proportion to their distance from the eye.

The structural causes for these differences are:—(1) the flatness or slight curvature of the Crustacean cornea, which does not hinder the entrance of any light which falls radially upon it, and (2) the strong convexity of the facets in insects, which causes refraction of the rays to a focus in front of the retina, and consequently a diminution of the light which meets them; thus most of the hurtful rays —those whose direction is not exactly at right angles to the surface of the cornea—having entered the eye at its side, are again thrown to the side and absorbed by the walls and the pigment of the narrow tube, whose diameter at the apex only allows of the entrance of a small central pencil. With regard to the fate of strongly divergent rays, the refractive properties of the cornea would appear calculated to increase their brightness; but this is the case only with objects at short distances, and has the advantage of giving distinct and recognizable images of objects within this range.

Nervous System of the Strepsiptera.*—The nervous system of the Strepsiptera has not been subject to any special researches. C. Th. von Siebold † only states that these insects (*Xenos vesparum*) have one thoracic ganglion; but he does not say anything about the number of cephalic and abdominal ganglia. E. Brandt's researches have been limited to four females and one male of *Stylops melittæ*, and one female *Xenos vesparum*, preserved in spirit, the results of which are as follows:—

1. The cephalic division of the nervous system consists of the *ganglion supra-œsophageum* only, the *ganglion infra-œsophageum* being absent.

2. The thoracic division consists of a large ganglion containing five pairs of nuclei; it is divided into two parts, an anterior and smaller one, corresponding to the *ganglion infra-œsophageum* and to the first thoracic ganglion of other insects, and a posterior and larger part, which corresponds to the other thoracic ganglia and to some abdominal ganglia. The interior division supplies nerves to the organs of the mouth (like the *ganglion infra-œsophageum*) and to the first pair of legs. The posterior and larger division of this ganglion supplies nerves to the second pair of wings, to the thorax, and to different segments of the abdomen.

3. The abdominal division of the nervous system consists of one abdominal ganglion, situated in the last third of the body. It is

* Abstract by the author of a memoir in Russian, St. Petersburg, 1878. Ann. and Mag. Nat. Hist., ix. (1882) pp. 456–7.

† Lehrb. d. vergl. Anat., i. (1848) p. 582.

oval, and is connected with the thoracic ganglion by means of a long thin cord. From this ganglion spring three pairs of nerves, of which the first and second pairs branch out in the fifth and sixth segments of the abdomen, while the last pair branch out in the last segment of the abdomen and in the rectum.

This nervous system is as curious as that of some Coleoptera (*Rhizotrogus solstitialis*, *Serica brunnea*) and some Hemiptera (*Hydrometra lacustris*), as it has no *ganglion infra-œsophageum.*

Insects which injure Books.—Professor A. Liversidge, of Sydney, sends us some specimens of *Lepisma saccharina*, and points out that "in Blades' 'Enemies of Books,' 3rd ed. (1881) pp. 61–3, he refers to the description of a book-worm in Hooke's 'Micrographia' (1665), and rather makes fun of the figure and description there given—'certainly R. Hooke, Fellow of the Royal Society, drew somewhat upon his imagination here, having apparently evolved both engraving and description from his inner consciousness.'

People living in New South Wales and other of the warmer parts of Australia can, however, bear testimony to the accuracy of Hooke's statements and drawing. The insect figured in the 'Micrographia' abounds here amongst books and papers, and is wonderfully destructive to them. It does not do so much harm to books as it does to loose papers, maps, labels, &c., as it cannot well get in between the closely pressed leaves of a book, and it is on this account that the loose edges of piles of MS., bundles of letters, &c., suffer so much more than the central portions; writing paper, too, probably contains much more attractive matter in the way of size, &c.

With this I enclose some scraps of paper showing the ravages of the insect (*Lepisma*), and also some of the 'silver fish' themselves, by which name they are commonly known here and also in India, whence I understand the name 'silver fish' originated.

The destruction of labels is a very serious one, as the identity of a specimen may very soon be lost. The labels enclosed have only been written about fifteen months, and some hundreds have thus been rendered totally useless. In future it will be necessary to saturate the labels with a poison, such as corrosive sublimate.

At times I have thought that, perhaps, the 'silver fish' instead of doing harm may be doing good—for wherever they are found we are likely to find pseudo-scorpions (*chelifer*), and it *may* be that the former prey upon the latter; though I think not."

Formation of Galls.*—M. W. Beyerinck finds that "galligenesis" affects a portion of the vegetal tissue, which becomes altered in character, and may then be known as *galliplastema;* the galligenetic influence is due to the larvæ and not to the hymenopterous parent. The phenomenon of formation of the galls is absolutely independent of the lesions which the deposition of the eggs causes in the living tissues of the plant. Direct contact between the animal and the plant is not necessary for the production of the galliplastema; there may be a layer of dead cells, or even the covering of the egg

* Rev. Internat. Sci. Biol., ix. (1882) pp. 373–4.

between them, and this intermediate space may be greater than the diameter of the larva. In the cases in which the animal that produced the gall had originally only one point of contact with the galliplastema, the further inclusion of the larva is due to an annular investment of the plastema, which increases in extent and becomes folded over it. A temporary contact on the part of the larva does not produce a gall. The larvæ are fed by the development in the gall of a tissue the cells of which have thin walls and contents rich in oil and albumen. In their anatomical structure many of the galls have characters which appear to be completely foreign to the organization of the plants that nourish them.

γ. Arachnida.

Anatomy of Phalangida.*—Dr. R. Rössler finds that the *digestive* system consists of three portions, of which the spacious midgut is provided with a large number of cæca; the sucking action is produced by a layer of strong transversely-striated circular muscles, which is only continued on to the more anterior portion of the succeeding œsophagus; the lumen of this latter region is almost completely filled up by six longitudinal folds, consisting of a transparent cuticle with a subjacent layer; the cells of the salivary glands may be seen, in section, to form one layer and two smaller complexes below the œsophagus; the secretion has an acid reaction. All the thirty cæca are without a muscular investment, and consist only of a thin fat-layer, a tunica propria, and an epithelium; the Malpighian vessels are represented by two tubes, forming a loop, which are placed near the median ventricle, and open not into the intestinal tract, but into two sacs on the ventral surface of the animal.

The *genital* organs of the two sexes are referable to a common plan, consisting as they do of an unpaired germinal gland, semicircular in form, lying freely in the body-cavity, and only surrounded by a rich supply of tracheæ; there is connected with this gland a paired efferent apparatus, which however becomes united into an unpaired piece, and finally opens to the exterior in the median ventral line, between the cephalothorax and the abdomen. Connected with the terminal portion is a copulatory organ, into the anterior portion of which there open a pair of accessory gland-organs; the penis is rod-shaped, the ovipositor is cylindrical, and the vagina has a seminal pouch on either side. The testis is a simple tubular organ about 4 mm. long and 0·4 mm. wide; the spermatozoa are large, biconvex, rounded cells, with a lens-shaped nucleus; the vasa efferentia commence as two fine canals, and soon form a close coil; the cells of the lumen become commingled with the products of the testis; the propulsion-organ has a thick muscular layer, the fibres of which are transversely striated, and there is a thick chitinous layer secreted by the epithelium; the lumen of the ductus ejaculatorius is narrow; chitin is also to be found in the penis. The ovary is horseshoe-shaped, invested by transverse and longitudinal muscular fibres, and when mature is beset with a

* Zeitschr. f. wiss. Zool., xxxvi. (1882) pp. 671–702 (2 pls.).

large number of follicles of various ages. These, which may be looked upon as evaginations of the tunica propria, all contain an egg, more or less developed, but the ova are always of small size until they make their way into the uterus, which then attain their full size and development. In the immature female the uterus is only apparent as a slight outpushing of the oviduct, but at the period of maturity it becomes turgescent, swells out, and occupies a large portion of the body-cavity; it is provided with a powerful layer of circular muscular fibres, and its inner surface is lined with cells, similar in character to those of the vas deferens. The terminal portion of the vagina is surrounded by a system of chitinous rings; the ovipositor, like the penis, is surrounded by two sheaths, which are essentially of the same structure in all the species.

The two glands at the lateral margins of the cephalothorax have been regarded by Loman as stink-glands; the author finds that in *Opilio albescens* there is an aromatic odour, which he ascribes to these organs.

Scent-glands of the Scorpion-spiders (Thelyphonus).*—The remarkable Arachnidan genus *Thelyphonus* is confined in its distribution to South America and Southern Asia and their islands. Of its internal anatomy nothing but the nervous system is known. The French zoologist Lucas states that the *Thelyphoni* are called *Vinaigriers* by the inhabitants of Martinique, on account of the strong vinegary odour which they emit when touched or handled. Stoliczka, who examined living specimens of one of the Indian species, states that a peculiar but *inodorous* fluid issues from two internal pyloric (!) appendages. These Arachnids, according to Lucas, live in damp places under stones on the ground. Stoliczka and Mr. Peal found them beneath the bark of decayed trees in groups.

Mr. J. Wood-Mason, who has undertaken an investigation of their anatomy, was only able to obtain specimens for dissection during the heaviest rain, when all vegetation and the ground is saturated with water, and the animals come forth from their holes in the rocks. He found that death quickly followed their removal from their humid haunts, air saturated with moisture being apparently necessary for the due performance of their respiratory functions. All the specimens he met with emitted, when touched, a most powerful and lasting odour, exactly like that of a highly concentrated essence of pears, which when deeply inspired had all the characteristic smell and pungency of strong acetic acid. This odour did not emanate from the general surface of the body, but proceeded from a pellucid fluid which exudes from the neighbourhood of the anus and is secreted by special glands. These are paired and tubular organs of huge size, extending from the nineteenth somite of the body (on which they open by two minute valvular apertures placed at the sides of the anus) to the front end of the thirteenth in the male, but to the middle of the eleventh in the female (whose glands are consequently the larger), and being, with the exception of the voluminous liver, the most conspicuous of the viscera. They are two subpellucid bags, shaped somewhat like

* Proc. Asiatic Soc. Bengal, 1882, pp. 59–60.

an Indian club, striped longitudinally with white, and filled to distension with a thin clear fluid. They are not quite equal, nor are they placed symmetrically in the body-cavity, but the one or the other lies between the nervous chain and the ventral body-wall in the middle line between the two rows of vertical muscles, and the other between the row of muscles and the lateral wall of the side of the body to which it properly belongs. They apparently consist of a strong and structureless basement membrane, invested externally by a layer of delicate striped muscular fibres arranged circularly, and of an inner membrane; the walls of the short (1 mm. long) ducts are transversely thickened so as to resemble the tracheæ of insects; the granular tissue is arranged between the two membranes in longitudinal plated stripes, so as to permit of the expansion of the lumen of the tubular organ in a receptacle or bladder for the storing up for use of the secreted fluid, to which apparent arrangement of the granular substance the striped appearance of the organs is due.

The secretion doubtless serves to protect the animal from attack, and it is interesting to find that the female in this, as in so many other animals which are similarly protected by their offensive odour, is (as being for obvious reasons the more important sex) more perfectly protected than the male by having, not indeed, so far as could be detected, a stronger and ranker, and therefore more disagreeable scent, as in many insects, but larger scent-secreting glands. Another point of interest brought out by this investigation is that the two glands exhibit a tendency to coalesce and form a single unpaired median organ, the two being always unequal and occasionally partially united and the one in the middle line invariably the larger.

These structures seem to belong rather to the category of excretory organs than to be highly developed skin-glands; and they are probably homologous with the silk-glands of other Arachnida and of Insects, with the green-gland of the Crayfish, and with the segmental organs of Worms and *Peripatus*.

δ. Crustacea.

Classification of the Brain of Crustacea.*—Dr. A. S. Packard gives the following provisional grouping of the brain of Crustacea, which he considers to be justified by known facts, although excepting the brains of Decapoda and *Limulus*, no special histological work has been accomplished. The terms archi-cerebrum and syn-cerebrum have been proposed by Professor Lankester, the first to designate the simple worm-like brain of *Apus*, and the second the composite brain of the Decapoda, &c.

Syn-cerebrum	Decapoda. Tetradecapoda. Phyllocarida. Cladocera. Entomostraca.
Archi-cerebrum	Phyllopoda. Merostomata (*Limulus*). Cirripedia ?

* Amer. Natural., xvi. (1882) pp. 588–9.

The syn-cerebrum of the Tetradecapoda, Amphipoda, and Isopoda, judging by Leydig's figures and his own observations on that of *Idotea* and *Lerolis*, is built on a different plan from that of the Decapoda. The syn-cerebrum of the Phyllocarida is somewhat like that of the Cladocera and Copepoda (Calanidæ); being essentially different from that of the majority of the Malacostracous Crustacea. The Copepodous brain is an unstable, variable organ, but on the whole belongs to a different category from the syn-cerebrum of other Neocarida.

We have then, probably two types of archi-cerebra, and three types of syn-cerebra among existing Crustacea.

Unpaired Eye of Crustacea.*—In most Crustacea, besides the two compound eyes (fused together in the Cladocera), there exists an unpaired median eye. It exists alone in most of the Copepoda, and in all naupliiform larvæ. Wherever the two kinds coexist in the adult but not in the newly hatched larva, the unpaired eye is the first formed, and must therefore be regarded as the primitive eye of the Crustacea. By thin sections of *Cyclops* and *Diaptomus*, Mr. M. M. Hartog has ascertained that this organ is of a much more complicated composition than had been supposed. The pigmented mass is, so to speak, structureless; the colouring-granules in it are placed at the surface contiguous to the "crystalline spheres." Each sphere is composed of radiating elements, the inner ends of which are applied against the pigmented mass, while the peripheral segments contain a nucleus. The eye is situated upon the terminal process of the brain, from which the optic nerves originate, one for each sphere; the nerve, instead of penetrating into the pigmented mass, *skirts the outer surface of the crystalline sphere, and penetrates it directly* not far from its hinder margin. The author has also found in the Phyllopoda a perfect analogy of structure with that just described in the Copepoda, and therefore concludes that the unpaired eye in all the Crustacea that possess it, is composed of three simple eyes, placed anterior to the brain, *with reversed optical bacilli, receiving conductive fibres of the optic nerve upon their outer margin*, and brought so close together that their pigmented or choroid layers are combined in a single mass.

A nearly identical structure may be detected in the Chætognatha, which have the triple eye of the Crustacea; but, instead of being median and unpaired, it is repeated on the two sides of the head; certain Planarians, *Dendrocœlum lacteum* for example, have two paired eyes, which, according to Carrière, have the structure adopted by the author for one of the simple eyes united in the median eye of the Crustacea.

It is probable that the eye of the Chætognatha and Crustacea is to be referred back to the type of the Planarians, but that the two former groups have no direct relationship between them.

Blood of the Crustacea.†—G. Pouchet is reported to find that the differences seen in the blood of these animals is not, as Wharton

* Comptes Rendus, xciv. (1882) pp. 1430–2.
† Journ. Anat. et Physiol. (Robin) xviii. (1882) pp. 202–4.

Jones thought, due to differences in the time of year. Their blood is remarkable for the large quantity of sea-salt which it contains, a drop from a *Maia* laid on a glass slide and dried giving a large number of crystals. Coagulation takes place very rapidly. Notwithstanding the great variation in form of the leucocytes, it is possible to recognize a common type; a large number have the form of young blood-corpuscles of oviparous vertebrates; as they grow older they present a number of granulations, and, as their nucleus is then often small or altogether lost, the author is of opinion that the granular condition represents the last stage in the development of these bodies. The form and the size appear to differ considerably as we pass from one species to another; the form, which is always ovoid, appears to be permanent so long as the blood is retained within the circulatory cavities; as an example of this we may cite the case of *Palæmon*, where the leucocytes found in the lateral lobes of the telson did not, during a long period of examination, exhibit any amœboid changes.

Pyloric Ampullæ of Podophthalmate Crustacea.*—F. Mocquard describes the ampullæ as forming the floor of the median part of the pyloric duct; in most cases they may be compared to two demi-cylinders placed side by side, with the cavity upwards. The surfaces are not, however, regularly cylindrical, for they are rounded and truncated obliquely behind. Their inner edges unite to form a projecting longitudinal—*interampullar*—fold; from their cavities and from the sides of the fold there arise a large number of parallel longitudinal crests, on the free edges of which there are rows of extremely fine setæ; from this arrangement there results a considerable number of small prismatic canaliculi, directed from before backwards; the free edge of the posterior portion of each of these ampullar crests is continued into a large seta, which is directed backwards and carries extremely fine setæ. A remarkable point in this arrangement is that very slight differences are found even when the Stomapoda are compared with the Decapoda. Similar ampullæ are to be seen in the larvæ (and doubtless also in other forms) even when there is no gastric armature; while further, though absent in the *Mysis*, they are to be found in the Mysis-stage.

We never find any appreciable amount of food in the ampullar cavities, and their functions would appear to be this: while the nutritious matters which are difficult of digestion remain in the superior portion of the pyloric duct, the more finely divided particles make their way between the interampullar fold and the side-wall of the pylorus along a line parallel to, but in a contrary direction to that of the setæ; they are thus broken and brought into a sufficiently fine state to enable them to penetrate into the canaliculi, whence they pass backwards in a longitudinal direction. In support of this view, the author directs attention to the fact that the excretory ducts of the so-called liver empty their products not far from the posterior orifice of the canaliculi, where the alimentary matters and this secretion would therefore be brought into intimate contact.

* Comptes Rendus, xciv. (1882) pp. 1208–11.

Heterogeny of Daphnia.*—C. L. Herrick, in the course of researches upon the development of *Daphnia Schaefferi* (= *magna*), observed several interesting facts.

The embryo, before leaving the egg, in both summer and winter forms, is furnished with palpi on the base of the second antennæ, and a long appendage from the dorsal region of the shell. The former, though quite large in the embryo, is later nearly atrophied, remaining during life, however, as a wart-like process with two rather small spines. The latter is curved beneath the body, lying between the valves of the shell. After the escape of the animal from the egg this organ becomes the dorsal spine, and seems to serve as an aid to the complete moulting of the walls of the brood-cavity, with the first development of which the spine seems also to stand in intimate relation.

It is worthy of remark that not only the mature animal, after long confinement in aquaria, becomes smaller and stouter, and in other peculiarities resembles the smaller spined species of *Daphnia*, but that the young retain the dorsal spine and the shorter form till in a sexually mature condition, when in confinement. This fact, and the discovery of Dr. Birge, that the spine upon the head of another species of *Daphnia* is also an embryonic organ, serve to call attention to the systematic position of this genus. It would therefore appear that the species *Schaefferi* is the culmination of a cycle of forms, among which are to be counted more or fewer of the species described as distinct.

Daphnia thus furnishes another example of so-called "Heterogeny."

Notodelphyidæ.†—W. Giesbrecht describes the female reproductive organs of these parasitic Copepoda. The ovarian tubes are completely differentiated before the last ecdysis, when they present the following features; there is a structureless *tunica propria* lined by a simple epithelium, the cells of which are as broad as high. As changes occur, this epithelium becomes separated off from the wall of the tube; the process commences at the anterior end, and gradually passes backwards, so that in a series of sections the anterior ones are filled with the separated cells, while the lumen of the hinder ones is still open and the wall invested by epithelium; the cells do not break off separately but in longitudinal rows. When this process has come to an end, the walls of the tube are formed by a distinct membrane, which is lined by a layer of protoplasm; at first the nuclei in this latter are at some distance from one another, but they soon come to form groups of two to six. The tube, therefore, first had the function of a germ-producer, and may be called the *ovary*, while, later, it serves as an *oviduct*, and affords nutriment to the growing ovarian cells. Owing to their coming off in longitudinal rows, the ova now lying in the tube are arranged in cords of a cylindrical form, each of which may have as many as one hundred eggs; there is no investing membrane to these ovarian cords. A little later the

* Zool. Anzeig., v. (1882) pp. 234–5.
† MT. Zool. Stat. Neapel, iii. (1882) pp. 293–372 (3 pls.).

separate cells begin to be distinguished from their neighbours; many of them increase in size by the growth of their peripheral portion, and the internal contents of these do not therefore become altered in character. Others develope within themselves fatty bodies. Under the influence of the growing ova the paired portions of the ovarian tubes increase greatly in diameter, and soon after this the eggs make their way into the maternal cavity, where they pass through the stages of development prior to the Nauplius condition. The dorsal folds are chiefly formed of a connective tissue, which consists largely of membranous elements and partly of spindle-shaped fibres, which may be regarded as muscle-cells; in addition to these there are rounded fibres, which extend from one surface to the other. Rounded or ellipsoidal bodies are to be found lying in the meshes of the tissue, filled by a very regularly arranged polyhedral meshwork of very delicate membranes. A number of fatty cords traverse the appendage in a radial manner; these are processes of the fat-body which is so frequently found in parasitic Crustacea and are here particularly well developed. The investing membrane is a continuation of the general chitinous covering of the body, though it is here more delicate than in other regions. As there is in all essential points the very closest agreement between the structure of these folds and that of the other parts of the body, it would be better to speak of them as processes of the body-cavity, than as dermal folds. The specially modified portion which serves as a brood-pouch has its internal lamella formed by a specially thick chitinous membrane, and is at first so folded as to allow of the increase in size of the cavity which becomes necessary later on.

Some of the habits of these forms are treated of in detail, and it is pointed out that the first copulation commences before the final ecdysis of the female, but the attachment of the spermatophores only becomes completed after the ecdysis; in this action of the male, the appendages, and specially the fourth or fifth pair of feet, take part. Various males may fertilize the same female who remains completely passive during the whole act. The reason of this apparently premature copulation is considered, and the suggestion is made that it is an arrangement derived from an earlier condition in which the female did not pass through the last ecdysis.

The succeeding acts of oviposition and delivery are described; they are repeated at regular and constant intervals, whereas the later acts of copulation are not so definitely arranged. A female who has just deposited her ova, has a thin, faintly-coloured, hardly detectable ovarian tube; five days afterwards this is again filled, and the red eye-spots of the embryos in the brood-cavity can be made out. After ten days from oviposition, the embryos are ready for extrusion, and again the ovarian tube will be found full; for about two and a half days the brood-pouch remains empty.

The author does not look upon the development of the fat-body as an arrangement which owes its origin to the struggle for existence, but as a passive necessary result of the parasitic habits of these animals; the assimilated nutriment which the free-living forms use

up owing to their activity, has no use in an organism which lives a parasitic life; and the physiological process is therefore completely similar to that which obtains in fattened cattle.

The earlier part of the paper is taken up by (1) an account of the presence of these forms in certain Ascidians, the author only finding them in *Phallusia mentula*, and *P. mammillata*, where they are far from being the only guests; (2) a description of their external form; and (3) a systematic account of the species, which are arranged under the genus *Doropygus*, with as subgenera, *Doropygus* and *Notopterophorus*. Seven species appear to be known.

Organization of Trilobites.*—The veteran H. Milne-Edwards, in discussing the results of the researches of Mr. Walcott,† concludes that the alliance, on which he long ago insisted, between the Trilobites, Isopoda, and Phyllopoda, is strengthened rather than weakened by these studies; he cannot believe that they were representatives of the Arachnidan type from which the *Limuli* appear to have been derived, and he thinks that a group composed of Trilobites, *Limuli*, and Eurypterina would be altogether artificial and inadmissible into a natural zoological classification.

It is pointed out that although there is, at first sight, a very considerable resemblance between young *Limuli* and young Trilobites, yet that the latter soon become provided with thoracic segments, and, to cite characters of less importance, they tend to become ornamented with those long spiniform prolongations, the presence of which is so characteristic not only of Zoeæ, but of many adult Macroura.

If we examine the respiratory organs of the Trilobites, we find them to differ much more from the *Limuli* than they do from the Branchiopoda or the Hedriophthalmata. The principal differences between the external structure of a *Limulus* and of a Phyllopod or an Isopod are to be found in the relations of the mouth to the appendicular system, and the mode of division of labour between the different parts. In the *Limuli* we find two distinct groups: one forms a masticatory, prehensile, and ambulatory system, at the centre of which we find the mouth; the other, the respiratory apparatus, is situated more posteriorly, and presents none of the characteristic forms of any Arthropod walking limb; no known existing animal has a similar structure, and no one of the recently observed facts leads us to see any close resemblance to them in the Trilobites. Prof. Milne-Edwards has now no doubt as to the existence of a long series of post-cephalic limbs in the Trilobites, and the characters of these appear to him to present a certain resemblance to those of *Apus*; it is possible that they were almost altogether homomorphous and natatory rather than ambulatory. It is pointed out that we have an erroneous idea of the essential characters of the appendicular apparatus of the Phyllopoda, if we imagine that they are always entirely soft and membranous; in *Apus* the coxopodite and some of the succeeding joints of the internal ramus are thick and firm, and we can imagine that under the

* Ann. Sci. Nat. (Zool.) xii. (1881) Art. No. 3, 33 pp. (3 pls.).
† See this Journal, i. (1881) p. 736

effects of fossilization nothing but the parts of this internal ramus might be left to be preserved.

Vermes.

Chemical Composition of Tubes of Onuphis.* — Professor O. Schmiedeberg finds that the tubes of this Annelid consist not only of a mixture of albuminoid substance and of potassium and sodium, but of a special body (onuphin) made up of organic and inorganic bodies; the presence of this body may be explained by the view of Ehlers that the tube is a secretion of the separate segments of the animal, a view which is based on the plentifulness of the secretion of certain glands. The question of the origin of the chemical components is considered by a reference to the quantitative analyses of various sea-waters, and it is pointed out that the striated structure of the tube is due to the different layers being separated by an albuminoid substance. The question of their food is not yet satisfactorily settled, nor have we yet the necessary knowledge of the exact constitution of onuphin.

Nematoid Hæmatozoon from a Camel.† — Dr. T. R. Lewis, recalling the fact that the occasional presence of nematoid organisms in the blood of various animals has long been ascertained, and that ten years ago he had shown that in India a somewhat similar condition was observable in man (associated with certain forms of grave disease), points out that an important contribution to our knowledge of the hæmatozoa of the lower animals has been made by Dr. G. Evans, the head of the veterinary department of Madras, who, whilst making a post-mortem examination of a camel, found that the blood of the animal swarmed with the brood of a nematoid parasite resembling the hæmatozoon of man. Dr. Evans found, further, that the parental form existed in the lungs, the pulmonary arteries of which were plugged by tangled masses of the thread-like parasites. They were also found in the mesentery.

A comparison of these hæmatozoa with those found in man shows that, whereas the embryonal forms of both kinds are indistinguishable under the Microscope, nevertheless the mature form as met with in the camel differs, both as to size and structure, from the only male and female specimen of the mature form met with in man which has hitherto been obtained in India; and so far as Dr. Lewis is aware, this hæmatozoon of the camel differs from any hitherto described parasite. Should further inquiry confirm the supposition that the parasite is new to science, he proposed that it should be called *Filaria Evansi*. A preliminary description is given of both male and female forms.

Development of Marine Planaria.‡ — Among other important points, Prof. E. Selenka here discusses the affinities of the Planaria to the Ctenophora and the Nemertinea. We find a considerable

* MT. Zool. Stat. Neapel, iii. (1882) pp. 373-92.
† Proc. Asiatic Soc. Bengal, 1882, pp. 63-4.
‡ Zool. Studien, ii. (1881) 44 pp. (7 pls.).

though not complete similarity in developmental history between the Planaria and the Ctenophora. In both cases (1) the endoderm arises as four large pale cells, and this layer gives rise to a quadri-radiate enteron, which is permanent in the Ctenophora, but modified in the Planaria. (2) The gastrula arises by epiboly, and the blastopore and permanent mouth are coincident in position. (3) Stinging cells are to be observed in both. (4) The embryo has in both a predominantly radial (symmetrical) arrangement, but in both this is later on more or less completely modified into a bilateral symmetry. On the other hand—(1) There does not seem to be in the Planaria more than a feeble indication of an aboral sensory capsule with otoliths, such as seen in the Ctenophora. (2) A complete investment of cilia is but rarely found in the Ctenophora, e. g. embryo of *Eucharis*. (3) Nothing comparable to the eight ctenophoral plates of the Ctenophora can be detected in the Planaria. The relations of the Ctenophora and the Planaria are hardly to be doubted.

Turning to the Nemertinea, we find that in these the quadri-radiate symmetrical cleavage is confined to the very earliest stages, the endodermal cells are small, and there is no kind of communication between the enteron and the cœlom; on the other hand, stinging organs are to be found on the proboscis, the blastopore and permanent mouth are coincident, and, in fine, the Planaria in some cases present intermediate conditions between the Nemertinea and the Ctenophora.

The chief objects of the author's investigations have been *Leptoplana tremellaris*, *L. alcinoi*, *Eurylepta cristata*, and *Thysanozoon diesingi*.

Eyes of Planarians.*—Former investigations † having done little more than elucidate the *external* characters of these organs, J. Carrière has applied himself to determining their intimate structure, especially that of the nervous elements. The method employed was preservation by Lang's method, viz. a liquid composed of chloride of mercury 5 parts, glacial acetic acid 5 parts, water 100 parts; after twenty minutes or half an hour the specimen was transferred to alcohol of 70 per cent.; sections were made and stained with picrocarmine.

In *Planaria polychroa* there is an optic ganglion immediately in contact with each eye, on its outer side, and consisting of an external layer of nuclei resembling those of the cerebral ganglion, and about ·008 mm. in length, enclosing a larger mass of fine fibres. Among these fibres are some which are strongly refractive, and pass in straight lines inwards, swelling out, and ending in rather broad knobs within the pigmented hollow ("pigment-cup"), and which they probably fully occupy in life. The pigment mass consists of small globules, varying in size from $\frac{1}{1000}$ to $\frac{4}{1000}$ mm. in diameter. The eye of *Dendrocœlum lacteum* is double; the pigment-cup is single, but has two posterior openings instead of one. The eye of *Leptoplana tremellaris*, described by Keferstein in very different terms, appears, however, to agree

* Arch. Mikr. Anat., xx. (1881) pp. 160–74 (1 pl.).
† See this Journal, i. (1881) p. 605.

essentially with those just described. Study of pathological and abnormal specimens appears to show that the large eyes of the two former Planarians have been developed from aggregations of small ones, each consisting of a nervous cell invested by pigment; such eyes, in fact, appear in some cases as accessory appendages to the main organs. *Polycelis nigra* has the margin of the anterior end of the body beset with pigmented ocular organs, which are often united together in twos or threes. Their structure differs, however, very widely from that of the eyes of *Planaria polychroa*. Each eye consists of a homogeneous sphere, invested on its posterior side with a pigment-cup of distinct granules, which is open in front; in contact with the back of the latter organ is a large transparent hemispherical nucleated cell. The eye appears to be surrounded by ganglion-cells whose nuclei are distinct, but whose exact relations to the eye have not been made out.

Development of the Orthonectida.*—C. Julin, although agreeing with Metschnikoff in regarding *Rhopalura ophiocomæ* and *Intoshia gigas* as the male and female forms of the same species, has never been able to detect them both in the same Ophiurid. When an *Amphiura squamata* infested with males is opened there escape hundreds of individuals in different stages of development. After the first cleavage one of the blastomeres is very much larger than the other, and is more opaque; this is the ectodermic while the other is the endodermic globule. The former gives rise to as many as fourteen cells before the latter divides at all; thus there arises a condition of epiboly, where the endodermic cell is ovoid in form and has its long axis parallel to that of the embryo; the enclosed cell now undergoes division, and gives rise to a small cell at either end; one of these occupies the orifice of the blastopore. These small cells now divide into six and four respectively, and the ectoderm becomes completely ciliated; as the embryo elongates the small cells increase in length, and becoming fusiform completely envelope the central endodermal mass; in the adult they form the longitudinally striated fibres. Meantime, the central endodermic cell has divided into a large number of smaller cells, each of which contains a fragment of the primitive endodermal nucleus; each of these gives rise to a spermatozoon. Although the primordial muscular cells have been given off from it, the central cell still possesses a true membrane, which persists during the whole life of the animal and forms a pouch for the contained spermatozoa.

While the males are free the embryonic females are connected together by a granular mass (the sporocysts of Giard, plasmodial tubes of Metschnikoff). There would appear to be very great difficulties in the study of their earlier stages owing to this mode of connection. But here also there is ectodermic epiboly, though the endodermic cell divides earlier to give rise to a mass of polyhedral cells, surrounded by a layer of cubical non-ciliated cells. Later on these peripheral cells become cylindrical, and still later they form a com-

* Bull. Sci. Dép. Nord, iv. (1881) pp. 309–18.

plete but very delicate layer of fibrils, apparently comparable to the muscular layer found in the corresponding position in the male. The central polyhedral cells give rise to ova. There is, therefore, an essential agreement between the developmental processes of the male and female.

The male products escape, by the rupturing of their investing wall, into the muscular layer, where a passage is found for them; the ectoderm undergoes change and atrophy, and the spermatozoa make their way out. The ectoderm of the female breaks off at a non-ciliated region at the anterior end, and thus the ova escape. There is another female form which seems to divide into two or three pieces, and which is distinguished by being flattened, and not cylindrical.

The females, when mature, appear to leave one host to swim in the water and to enter another, and there is some reason to believe that the cylindrical forms give rise to the males, while the flattened forms would seem to be the parents of the females. These latter possibly arise by parthenogenesis.

The author promises a fuller paper, in which he will give more details and full reasons for his belief that the Orthonectida belong to Van Beneden's group of the Mesozoa, and he concludes with an objection to the application of the terms metamere or segment to these creatures, as the segmentation is superficial, affecting only the ectoderm, and the number of segments does, it is allowed, vary.

Eyes of Rotifers.—Referring to his note read at the June meeting of the Society,* Mr. Badcock writes (July 17):—"Yesterday for the first time I discovered eyes in a group of adult *Floscularia cornuta*, and saw them again very distinctly in *Stephanoceros eichhornii*. It seems to me desirable to put on record the fact that the eyes are found in the adult forms of *Melicerta ringens*, *M. tyro* or *tubicularia*, *Floscularia cornuta*, and *Stephanoceros eichhornii*, in all of which the eye is ignored in the usual descriptions and drawings. The eyes are not *readily* seen, but I have had some very fine specimens, and may be able eventually to demonstrate their existence in all the forms in which they were supposed to have been lost."

Echinodermata.

Anatomy of Holothurians.†—E. Jourdan finds in the connective tissue of the integument of these Echinodermata elements forming a plexus; they are coloured grey by osmic acid, are rarely isolated, and are very often united into bundles. They arise from nerves which penetrate into and extend through the skin. The fibres of this nervous plexus are accompanied by nuclei, which are chiefly found at the points of interlacement of the fibres. These fibres are very fine, slightly varicose, and accompanied by fatty granulations. The nervous centres consist of fibres and cells. The latter are frequently, though not always, unipolar.

The muscular elements of Holothurians are made up of fibres

* See this Journal, *post*, Proceedings.
† Comptes Rendus, xciv. (1882) pp. 1206–8.

which are remarkable for the irregularity of their form and their length. They are always provided with one or more nuclei, which are always lateral in position, large in size, and attached to the fibre by a delicate sarcolemma. The walls of the Polian vesicles consist of an outer layer of flattened cells, which recall the endothelial lymphatic cell; a layer of connective tissue in which the fibres are longitudinal; a layer of circular muscular fibres, which are very long, and have the appearance, when extended, of elastic fibres, in a state of contraction. They present a number of swellings. Within this there is a layer of epithelial cells.

Hybridization of Echinoidea.*—R. Koehler finds that, at Marseilles, the genital glands of most species are mature in March or April. In making experiments, however, it is necessary to assure oneself by microscopical examination that the elements are ripe, and with the crossing experiments it is right to fecundate by their own spermatozoa the ova of the species treated. When the ova of *Strongylocentrotus lividus* were fecundated by *Sphærechinus granularis*, the *Pluteus* was regularly and perfectly developed. The same happened when the male was *Psammechinus pulchellus.* When the male was *Dorocidaris papillata*, the eggs did not pass beyond the blastula-stage, but the spermatozoa used were here somewhat inactive. A female *Strongylocentrotus* is not always fecundated by a male *Spatangus purpureus.* Sometimes, however, even the gastrula-stage may be reached.

Other examples are given, and the whole shows that cross fecundation is possible, within very wide limits, among the species of the Echinoidea; while the *Pluteus* derived from the crossing of two regular Echinoids may not differ much from the normal Pluteus of the female in the experiment, there are certainly well-marked differences between the legitimate Pluteus of a *Spatangus* and the hybrid Pluteus of that and *Psammechinus.* While the ova of one species may be fertilized by another, the reverse may not hold true.

Variation in Asterias glacialis.†—Professor Jeffrey Bell describes "six sets at least" of forms of this species. In the simplest there is never, in addition to the median row of spines along the back of each ray, anything more than a single isolated rather small spine on either side. Passing through forms in which there may be a few of these intermediate spines, or a larger number, we get to those in which there is a distinct row on either side of the now less conspicuous median one: two rows may be indicated on either side, or may be conspicuously developed. All the forms selected came from the coasts of Portugal, the Azores, or Madeira. It is pointed out that the character and arrangement of the pedicellariæ depends on the distribution of the spines, and it is, in conclusion, suggested that in the history of the Asteroidea the next point to work out "is the nature

* Comptes Rendus, xciv. (1882) pp. 1203–5.
† Zool. Anzeig., v. (1882) pp. 282–4.

of the sea bottom, of the surroundings, of the food, and of their enemies, as determining the strength, size, and disposition of the abactinal spines."

Cœlenterata.

Development of Calcareous Skeleton of Asteroides.*—G. v. Koch having observed that between the crystalline calcareous substance which forms the septa of *Mussa* and the hyaline connective substance that surrounds it, there are cells which form a continuous layer, asked himself whether these cells secrete the calcareous skeleton, and do they belong to the connective substance (mesoderm), or are they ectodermal in origin, and, therefore, a secretion from the primitively external surface, which is only apparently internal?

To resolve these questions he has studied the development of the skeleton in *Asteroides*, where he finds that the first indications are only to be observed some time after the larva has become fixed. These appear as a circular disk with a cavity in the centre, consist chiefly of carbonate of lime, and are composed of spheroidal pieces, made up of concentrically arranged layers. The spheroids are larger in the centre, and decrease in size as they approach the margin of the disk. This earliest skeletal rudiment lies between the lower layer and the ectoderm of its aboral surface. The cells of the latter, like those of all other parts of the surface of the body, are cylindrical, and no calcareous concretions are to be observed within them. From these facts the author concludes that the first rudiment of the skeleton is neither a product of the endoderm nor of the connective substance (mesoderm), but that it is a secreted product of the ectoderm. The further development of the skeleton is brought about by the completion and enlargement of this basal disk, and by the formation of septa. The former is effected by the formation of new spheroids, by growth, and by subsequent fusion; the septa arise from radial endodermal ridges which attain a considerable size. Later on, the ectoderm enlarges, and there appear calcareous secretions, formed of small crystals, which fuse with the disk, and form the first rudiments of the septa. In the next stage the septa are higher and begin to branch at their peripheral ends. Growing still more, they broaden out, partly into the form of thin lamellæ, get small spinous processes, and fusing at their peripheral ends with one another form the theca. The columella is similarly formed by a fusion of the central ends. While these changes have been going on there is a further secretion of carbonate of lime at the free edge of the young *Asteroides*. This unites with the aboral disk, and gives rise to a thin lamella. This is the epitheca of authors, and it is important to note that at first it is completely separate from the theca, and that it only secondarily becomes connected with it. Very little now remains to be observed, except the growth of the septa, theca, columella, and epitheca. We may remark, however, that from the primitively twelve septa there soon arise six which are stronger than the rest, and, alternating with them, appear to give rise to two cycles; twelve new septa

* MT. Zool. Stat. Neapel, iii. (1882) pp. 284–92 (2 pls.).

also begin to appear. Still later on, it may be seen that the septa form three or four cycles, which consist respectively of 12, 12, 24, and 48 pieces; the younger always appear between two older ones.

Development of Æquorea.*—Prof. C. Claus states that *Æquorea forskalea* deposits its ova in March. They are without an investing membrane, and are deposited in great quantities. The directive corpuscle is soon expelled, and just below the point at which it escaped a clear vesicle may be seen in the yolk for a few hours afterwards. The central cleavage-cavity is open at both ends until the 16-sphere stage. Later on, when these become closed, the region of the upper pole may be still distinguished by the greater thinness of the walls of the hollow sphere at that point. As the cells become smaller, cilia appear on the surface, and the mass begins to rotate. It soon, however, elongates, and becomes narrower near the lower pole, which is now posterior. The cells of this region become much higher, and gradually form a projecting process into the cleavage-cavity. Some of the more internal cells break away, and form isolated spheres within that space. This process goes on until the whole becomes filled with small cells, which represent the endoderm. At first there is distinct continuity between the endodermal cells, and the ectodermal from which they have arisen. On the third day the embryo presents all the characters of a *Planula*, and swims freely about. Stinging cells appear, and the long axis of the body is marked by a somewhat irregular line, which is the optical expression of a cleft in the endoderm. On the fourth and fifth days this cleft becomes wider and filled with dark granules. In this condition the larva swims about freely for some time. Fixation has not been directly observed.

This polar ingrowth of the endodermal cells is not any kind of delamination, but has, as the author hopes to show in a further communication, a not distant connection with the other mode of development, which is known as that of invagination.

Porifera.

Hybridization in Fresh-water Sponges.†—Mr. E. Potts, in exhibiting some fragments of fresh-water sponges collected in the Boston Aqueduct, consisting of, it is believed, *Spongilla paupercula* and a new species, *Meyenia acuminata* (with others), points out the following exceptional features as marking the collection: (1) that all the statospheres, whether belonging to *Spongilla* or *Meyenia*, were *smooth*, that is, without a granular or cellular "crust"; (2) the apparent absence of dermal spicules in both, and the abnormal character of these belonging to the statospheres. The appearance is not infrequent, but has, so far as known, heretofore been limited to the genus *Spongilla*. The recurrence of the same feature in the associated genus *Meyenia*, coupled with the fact that many of the birotulates upon its statospheres were imperfect, the rays being more

* Zool. Anzeig., v. (1882) pp. 284–7.
† Proc. Acad. Nat. Sci. Philad., 1882, pp. 69–70.

or less aborted approximating their shape to that of the spined fusiform acerates of *Spongilla*, gave rise to the suggestion that here, possibly, had been, not merely a mechanical mixture by inter- or super-position of species, but an organic hybridization produced by the flowing together of the amœboid particles of which the sponges are composed, or even by a fertilization of the ova of one by the spermatozoids of the other.

It is important to note that the specimens were collected in February, when the sarcode matter had nearly all been washed away with, probably, accompanying changes in the presence or numbers of the smaller spiculæ.

Boring Sponges.*—Mr. J. D. Hyatt, referring to papers in the Journal of the Quekett Microscopical Club (in which the question is discussed whether *Cliona* forms the burrows in which it is found or whether they are excavated by annelids or other animals), is convinced that there is one weak point characterizing all the observations, which invalidated to a great extent the conclusions on both sides. This was, that dried specimens had been used, or, as one author mentions, the live sponge occupying old shells and rocks. It occurred to him that a study of the live sponge occupying the shells of healthy, living molluscs, might present evidence for one side or the other that had hitherto been overlooked, and he therefore procured some oysters, a considerable number of which had shells tenanted by *Cliona*.

An exhaustive microscopical examination of these and similar specimens, seems to him to establish, beyond a possibility of doubt, that the sponge is, in this case at least, the only factor to be held accountable for the burrows. The outer layer of the shells was punctured with numerous holes, often many hundred, varying from the $\frac{1}{20}$ to the $\frac{1}{100}$ of an inch in diameter, generally occupied by the osculæ of the sponge. Between the outer and inner layers, and extending laterally, the shell was almost entirely excavated, and the space occupied by the sponge and its numerous spicules; while extending inward from this sponge-mass were innumerable minute, branching and ramifying burrows, uniformly and completely filled with corresponding arms of sponge, many of which extend quite through the interior layer of shell. The contact of these arms with the external membrane of the oyster causes the latter to deposit at such points an additional amount of lime carbonate, and the interior surface of such shells presents the appearance of numerous little prominences caused thereby.

The only possible theory that will account for these burrows, if they are not made by the sponge, is that they are the deserted excavations of worms; but this theory is untenable, as it would be necessary to suppose that the shell was once inhabited by an innumerable multitude of such worms; otherwise the perforations through the inner cell would have been closed, and all of these must have retreated at the same time, so completely that no trace of them could

* Amer. Mon. Micr. Journ., iii. (1882) pp. 81–4 (3 figs.).

be found, and the sponge must then have extended its growth into the deserted channels with such rapidity as to fill every minute branch before the oyster could bar it out by the secretion of enough new shell to stop apertures $\frac{1}{1000}$ inch diameter.

But this is not all. The burrows occupied by *Cliona* branch in all directions and diminish in diameter as they extend inward, which would represent a method of boring quite inconsistent with the habits of any known borer. Again, in these specimens, the sponge was found in small spots on the thin laminæ, around the sides and anterior edges of the shell which represent its most recent external growth, and in such cases the laminæ were perforated from side to side.

Protozoa.

De Lanessan's Protozoa.*—This will be found a welcome book by microscopists, as it is copiously illustrated with woodcuts and deals with the subject in a very readable form, while yet being far beyond a merely popular handbook.

The author's leading divisions are Monerans, Amœbans, Foraminifera, Radiolaria, Infusoria (flagellate, ciliate, and tentaculate), and he claims to have originated a new plan for such a book differing from that of ordinary treatises. He commences in each case with considering in its adult state an individual species chosen as the best type of the group (by its being readily procured, best known, &c.), dealing with all the details of its organization, with its physiological functions, its habits, and the development of its organs, considerable importance being given to embryology. He then describes the other leading forms of the group, and when all these have been disposed of a separate chapter sums up the common characters of the group, its relations with neighbouring groups, and its classificatory divisions.

The author considers that a great mistake is made when the converse course is adopted and the characters of the group are dealt with, noticing the peculiarities of the organization of the different types of the group in the course of the general description. By this method, he says, "a Mollusc becomes a kind of abstract entity clothed with characters rendered so vague by the generalization that the student has the greatest difficulty in discovering them in the specimen given him to dissect."

Taking the Amœbans for an example the following is the author's arrangement:—

1. The principal forms.

(*a*) Gymno-Amœbans. Under this head are described *A. princeps*, *A. coli*, *Podophrys elegans*, *Pelomyxa palustris*, *Dactylosphœrium radiosum*, *D. polypodium*, *D. vitreum*, *Hyalodiscus rubicundus*, *Petalopus diffluens*, *Plakopus ruber*, *Podostoma filigerum*, and *Mastigamœba aspera* (9 figs.).

(*b*) Theco-Amœbans.—*Pseudochlamys patella*, *Cochliopodium pellucidum*, *Difflugia oblonga*, *Quadrula symmetrica*, *Arcella vulgaris*, and *Amphizonella violacea* (6 figs.).

* J. L. De Lanessan, 'Traité de Zoologie. Protozoaires,' vii. and 336 pp. (281 figs.) 8vo, Paris, 1882.

2. Common characters, classification, and affinity.

The author defines Amœbans as Monerans which have acquired a nucleus and contractile vacuoles, and distinguishes 17 genera, a third group of flagellate Amœbans being here formed of the genera *Mastigamœba*, *Reptomonas*, and *Rhizomonas*.

Kent's Manual of the Infusoria.—This is now completed by the issue of the 6th part and forms a magnificent monograph of the Infusoria which cannot fail to be of the greatest value and assistance to the microscopist.

The concluding part has an appendix containing a notice of species recorded during the publication of the work, a glossary of technical terms, an extensive bibliography of the Infusoria, and a plate illustrating the apparatus employed by Messrs. Dallinger and Drysdale and by Professor Tyndall in their investigations on Monads, &c. The plate also contains a figure of a Microscope and lamp arranged for working with high powers, the Microscope being horizontal and the lamp turned with the narrow edge of the flame towards the condenser. The plan described is by no means the novelty which it is suggested to be; it is, in fact, the one adopted since the days of Quekett for all delicate high-power work.

Flagellata.*—In a previous communication J. Kunstler † recorded the results of researches undertaken on the Flagellata, to which more recent observations enable him to add some new facts.

Cryptomonas ovata Ehrbg., after being submitted to the action of acetic acid, appears to be covered with filaments; Bütschli, who has described analogous productions in *Chilomonas paramœcium* Ehrbg., considers that they are trichocysts, that is, organs of defence comparable to the nematocysts of Cœlenterata; the author, however, has never been able to see in this organism the small rods which are so abundant in the integuments of certain ciliated Infusoria, and within which, if the comparison with urticating organs is correct, the attenuated prolongations should at first be enclosed. The filaments, incomparably more numerous than those which have been figured by Bütschli, form a thick peripheral layer, and their length is often enormous, thus there are some ten times the length of the body; generally they take an upward inclination. At the upper part of the body, on the prolongation of the posterior margin of the hollow in the digestive chamber, two or sometimes three of these prolongations may be observed which are thicker, longer, and more rigid, whilst the others are often slightly flexible. *Cryptomonas erosa* also has these filaments.

In the cold season, *Cryptomonas ovata* acquires special characters. The nucleus only contains the large nucleolus. The cuticle is generally very thick over the whole surface of the body, and the vacuoles in it are very easily visible without the intervention of any reagent; in certain points this cuticle presents a very considerable development, for example at the lower extremity where it forms a

* Comptes Rendus, xciv. (1882) pp. 1432–3.

† Ibid., xciii. (1881) pp. 746–8. See this Journal, *ante*, pp. 62–3.

prolongation directed backwards, or better at the dorsal rostrum (which is itself prolonged) where it often forms a long point. It also presents, besides the line devoid of green colouring matter, the existence of which on the left face the author has already recorded, another, colourless, tolerably broad, longitudinal line through the whole length of the right face. Finally the starch-grains of the deep mamillated layer are rarer and very thin; but extending over almost every part of their body are seen some irregular more refringent corpuscles resembling concretions, which are perhaps also formed of starch, although they do not turn blue under the influence of iodine.

In an infusion that was in an advanced state of decomposition the author has met with *Chilomonas paramœcium* Ehrb. in a sort of palmelloid state; a number of individuals of this species being united in a common transparent gelatinous mass, having a great resemblance to a *Zooglea.* Cienkowski has observed an analogous phenomenon in *Cryptomonas polymorpha*, and was confident that it was a mode of reproduction. The author has never observed this phenomenon except in cultures which were more or less putrefied and placed in unfavourable conditions with regard to light; these organisms are always isolated and very active in clear water well exposed to the light. *Astasia costata* has a muscular, subcuticular layer with spiral fibrillæ analogous to those in the *Euglenæ.* The contractile vesicle of *Phacus pleuronectes* Duj. has distinctive vacuolar walls resembling those of the analogous organ in *Cryptomonas.* The terminal flagellum of *Monas vinosa* Ehrbg. that Cohn considers to be merely the mobile spore of *Clathrocystis roseopersicina* (a chromogenous bacterium), displays a transverse striation when it has been submitted to the action of reagents that colour strongly.

Cell-parasite of Frog's Blood and Spleen (Drepanidium ranarum).*—In 1880 we referred † to a discovery made by Dr. J. Gaule of certain *Würmchen* or "vermicles" in frog's blood, which he considered to be simply protoplasmic portions of the corpuscles separated for a short independent life, and not parasitic organisms. Prof. Ray Lankester now points out that these are, in fact, the minute, sausage-like parasites, discovered by him in 1871 (for which he proposes the name of *Drepanidium ranarum*), and that they are clearly parasitic organisms, probably the young stage of a sporozoon allied to *Sarcocystis* or to *Coccidium.*

Some of the chief observations of Dr. Gaule are, in fact, directly favourable to the view that the *Würmchen* are independent parasitic organisms, for (1) they exhibit active movements under circumstances usually favourable to the movements of the Protozoa and Protophyta; (2) they occur within the cells of the organism in which they are found as well as in its fluids; (3) they are present in some frogs and not in others living under approximately the same conditions; (4) they vary in abundance in the same frog, examined at different times;

* Quart. Journ. Micr. Sci., xxii. (1882) pp. 53–65 (5 figs.).
† This Journal, iii. (1880) p. 232.

(5) they are abundant in one time of the year and not at another; (6) they are seen on the stage of the Microscope to penetrate and enter cells by means of their active movement; (7) they are also seen to escape from cells by the same activity; (8) they are localized chiefly in the spleen though not confined to that organ; and (9) though most abundantly observed in certain specimens of *Rana esculenta* at Leipzig, yet they have also been observed in *Rana temporaria* and in *Triton* sp.

These observations are not merely consistent with the view that *Drepanidium* is an independent parasitic organism, but are directly in favour of that view, since they are readily explained if that view be admitted, whilst they remain as isolated and unconnected facts, each requiring a special assumption for its connection with any other theory which may be advanced as to their nature, when the obvious one that they are parasitic organisms is rejected.

The only fact which Dr. Gaule adduces which is inconsistent with the parasitic nature of *Drepanidium* is that in some cells, especially blood-corpuscles, these bodies are not present when an examination of them is first made on the field of the Microscope, and that on the addition to the preparation of 0·3 per cent. solution of sodium chloride the *Würmchen* are formed there and then in the cells. Prof. Lankester, however, doubts altogether the accuracy of Dr. Gaule's statements on this point, the supposed fact being really an erroneous interpretation of an observation. Just as the nucleus in the frog's red corpuscle is frequently not visible during life and only becomes visible as the result of the first change in blood removed from the blood-vessels, so *Drepanidium* is invisible in the normal condition of the red blood-corpuscle owing to the identity of the refractive index of its delicate substance and that of the body of the corpuscle. It only becomes visible when a change in the refractive indices takes place.

Prof. Lankester suggests that researches should be directed to the discovery of a Gregariniform stage, and of cysts containing spores, or of isolated spores in which several *Drepanidia* may be enclosed. These phases in its life-history are very possibly to be met with in other regions of the frog's body than the blood-vessels or the spleen.

Development of Trypanosoma.*—Dr. J. Gaule has also re-investigated the remarkable organism of Flagellate character found in frogs' blood, the so-called *Trypanosoma sanguinis* Gruby, and puts forward a decidedly new and original interpretation of it, arriving at the conclusion that it is not an independent organism, but is produced by spontaneous modification of the white blood-corpuscles. Its production is favoured in general by warmth, hence it is found in frogs more particularly at the commencement of the warm period of the year, and it may also be seen to occur during the winter in frogs which have been kept in a warm room. These conclusions are attempted to be supported by the fact that the direct and frequent

* Arch. Anat. u. Physiol., 1880 (Physiol. Abth.) pp. 375–92 (1 pl.).

conversion of white blood-corpuscles into *Trypanosoma* (or Kymatocytes as Gaule proposes to call them) may be observed on the warm stage.

The transmutation of the white corpuscles is said to take place as follows:—At one point in the periphery of the corpuscle is developed a vibrating flagellum from which is subsequently but gradually produced a hyaline undulating ribbon; ultimately the whole body becomes flattened out and the flagellum degenerates into a pointed process of the lobate mass thus formed. The fully developed kymatocytes show such exuberant multiplicity of forms that the writer is able to distinguish no fewer than five types among them. Conversely, however, the *Trypanosoma* have the power of being re-converted into leucocytes with amœboid movements. Gaule, according to his showing, has directly observed the process of re-conversion, which he describes, many times, and he elucidates it by pictorial representations of the successive stages.

One circumstance which appears to be of special importance in the matter is not made clear in the memoir, namely that as the white blood-corpuscles of the frog are known to be provided with a number of small nuclei, the *Trypanosoma* ought also to exhibit them, but neither are they described or do any cell-nuclei appear in the figures. This point seems to Prof. O. Bütschli * the more important, because in the life-history of certain Protozoa (cf. especially *Ciliophrys* Cienk.), amœboid and flagellate stages succeed one another, so that a similar alternation in the life-history of *Trypanosoma* proves nothing of itself as against their Protozoan nature. Indeed, the very point whether these amœboid bodies whose transmutation gives rise to the *Trypanosoma*, really are white blood-corpuscles, appears to Prof. Bütschli to be by no means free from uncertainty notwithstanding the present investigations. Prof. Lankester also considers † Dr. Gaule's views to be "devoid of justification."

New Gregarines.‡—Dr. R. Rössler found in the enteric canal (chiefly the cæca) of the Phalangida, among other parasites, two Gregarines which appeared to be new. *Actinocephalus fissidens* n. sp. has twelve pairs of cleft hooks on its head, and between each pair there is a simple spiniform process. *Stylorhynchus caudatus* has the "head" placed on a stalk, and provided with twelve ridges or projections, which extend beyond the margin of the head and then divide. This form is also provided with a delicate caudiform appendage, which is not separated from the body proper by any septum. In some cases these parasites were so numerous that the death of the host may be ascribed to their presence.

* Zool. Jahresber. Neapel, i. (1880) p. 165–6.
† Quart. Journ. Micr. Sci., xxii. (1882) p. 65.
‡ Zeitschr. f. wiss. Zool., xxxvi. (1882) p. 700 (2 figs.).

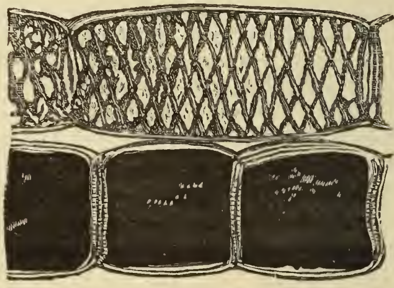
BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Chemical Difference between Dead and Living Protoplasm.—Dr. O. Loew sends us a photograph illustrating his researches on this subject,* from which Fig. 90 is copied.

The upper part of the woodcut shows a filament of *Spirogyra nitida* Ktz., *killed* by a 0·1 per cent. solution of citric acid before

Fig. 90.



treatment with the silver reagent, no blackening being produced, and the spiral arrangement of the chlorophyll-bands being distinct. The lower part shows a filament when placed in the *living condition* into the silver reagent, the reducing effect of the living protoplasm on the silver-salt having converted the cell-contents into a black opaque mass.

Killing of Protoplasm by Various Reagents.†—Loew and Bokorny have applied their test for distinguishing between dead and living protoplasm, viz. its power of reducing dilute alkaline silver solutions, to determine the degree of resistance offered by protoplasm to various destructive agents. After complete withdrawal of light for five days, about 50 per cent. of the filaments of several species of *Spirogyra* still showed signs of life; it was not till the sixteenth day that all were completely killed. Twelve hours' desiccation over concentrated sulphuric acid destroyed the appearance of life in almost every cell. Triturating in a mortar destroyed life, even where there was no apparent injury. After warming in water of 46° C. for a short time, about 10 per cent. of the cells still showed signs of life, at 55° about 2 per cent.; and a temperature of 60° altogether destroyed life. Exposure of one hour to vapour of ether destroyed life except in some cells containing a large amount of oil and in spores, sugar being formed during the process. After twelve hours in chloroform-water, 5 per cent. of the cells were alive; two days in petroleum

* See this Journal, i. (1881) p. 906; *ante*, p. 67, 361, and 440.

† Pflüger's Arch. f. d. gesammt. Physiol., xxvi. (1881) pp. 50–9. See Bot. Centralbl., ix. (1882) p. 392.

destroyed all power of reaction, causing copious formation of sugar; absolute alcohol destroys life in an extremely short time. Exposure for twenty-four hours to a stream of carbonic acid destroys the life of the cells. Hydrochloric acid and citric acid produce an injurious effect almost immediately. The power of resistance to alkalies is much greater. Immersion for one hour in a 10 per cent. solution of sodium chloride destroys most of the cells. Metallic poisons act more slowly; some cells still show signs of life after immersion for two hours in 1 per cent. solution of sugar of lead, or for twelve hours in 0·1 per cent. of arsenic acid, or for twelve hours in 1 per cent. of zinc vitriol. Of organic poisons, gallic acid, pyrogallol, resorcin, hydrochinon, in 1 per cent. solutions, act rapidly, destroying life in a few hours, as also 0·2 per cent. salicylic acid, and 1 per cent. carbolic acid in one hour. Alkaloids, acetate of strychnin, chinin, and very dilute veratrin do not prevent the reaction, although the structure of the protoplasm is destroyed; 1 per cent. sulphuric acid destroys the power of reaction.

Apical Cell-growth in Phanerogams.*—In order to determine the much-disputed cause of the want of a special apical cell in flowering plants, G. Haberlandt has closely investigated the process of apical cell-growth in the following instances: the cell-divisions of the cortical parenchyma in the laburnum and in the trichomes of the leaf-stalk of *Begonia Rex;* the formation of the stomatal apparatus and neighbouring cells in *Mercurialis* and in Crassulaceæ; the cell-divisions in the formation of the hypodermal bast-cambium bundle in the leaves of *Typha latifolia;* the formation of the midrib of the leaf of *Elodea canadensis;* and the formation of the leaves and axillary shoots of *Ceratophyllum demersum.*

The general conclusions arrived at are, that in Phanerogams there are tissues and masses of cells of very different extent and signification, which have been formed by apical cell-growth. It may be either rows of cells only that increase by apical growth, as in the first and second of the above instances, or plates of cells, as in the third, or finally masses of cells may exhibit apical cell-growth, as in the two last. Each of the three tissue-systems of Hanstein, dermatogen, periblem, and plerome, grows at first by means of a single apical cell.

Development of Bordered Pits.†—E. Russow has carefully investigated the development of bordered pits, and of the membrane of wood-cells, more particularly in the Abietineæ. The general conclusions at which he has arrived are the same as those of Sanio. The growth of the wall of the border points to the interpretation of a kind of secondary division-wall, as if a free membrane were excreted on the upper side of the protoplasm.

* Haberlandt, G., 'Ueber Scheitelzellwachsthum bei den Phanerogamen,' 29 pp. (2 pls.). Graz, 1881.

† SB. Dorpater Naturforsch.-Ges. Sept. 24, 1881. See Bot. Ztg., xl. (1882) p. 182.

Development of Tissue as a Characteristic of Groups of Plants.*—M. Westermaier thus sums up his conclusions on this subject. The results of anatomical investigations in reference to affinity differ according as the physiological idea of the subject is taken into account or not. In the latter case the result is either false or uncertain, while the former leads to a comparison on a rational basis. This last method of inquiry results in the conclusion that in the Primulaceæ the presence of a ring of bast may be regarded as an anatomical family character. In *Campanula*, while one group has in the stem the ordinary ring of vascular bundles with the phloem on the outer, the xylem on the inner side, a second group of the genus has a phloem-bundle in the pith, with or without xylem, a difference connected with physiological functions.

Stomata of Polycolymna Stuarti.†—The more or less complete fusion of two or even of three stomata into one, has frequently been noticed as an exceptional phenomenon. In *Polycolymna Stuarti* (Compositæ) F. Hildebrand states that it is so common, both on the stem and on the leaves, that it may be regarded as a normal occurrence.

The relative position of the two clefts in these double stomata varies greatly. In some cases they are parallel, in others at right angles to one another, while sometimes again one is behind the other, so that only one pore belongs to the two clefts. The mode in which the guard-cells are formed out of the ordinary cells of the epidermis appears also to be subject to great variation. The author was unable to determine whether the cells strongly charged with protoplasm divide directly into guard-cells, or whether this is only effected after repeated division; both processes appeared to take place. The direction of the septum in consequence of which the guard-cells are formed, is also very various; it is sometimes vertical, sometimes parallel to the wall by which the mother-cell of an epidermal cell is cut off. The occurrence of double, and occasionally of treble stomata, may be attributed to these numerous variations in the mode of their formation.

The stomata of *Polycolymna Stuarti* present also other peculiarities. The guard-cells are placed in various positions as to height in relation to the surrounding epidermal cells. Usually the outer walls of the guard-cells are about at an equal height with those of the surrounding cells, and this is almost invariably the case with double and treble stomata. But among these are others, distributed irregularly, the guard-cells of which are more or less elevated above the surrounding epidermis, this variation being possibly connected with their special function.

The number of stomata is about the same on the under and upper surfaces of the leaves; on the under surface they are protected by densely crowded glandular hairs, on the upper side by a dense felt of silky hairs. The stomata with most elevated guard-cells are found

* MB. K. Akad. Wiss. Berlin, 1881, pp. 1050–70 (1 pl.).

† Bot. Centralbl., ix. (1882) pp. 356–61 (1 pl.)

on the under surface. They are also very numerous on the upper part of the stem, where they are also protected by glandular hairs.

Properties and Mode of Formation of Duramen.*—J. Gaunersdorfer gives an historical *résumé* of what is known respecting the duramen, which is distinguished by frequently containing gummy and resinous substances in its vessels or cells, as well as large deposits of carbonate of lime. His own observations he sums up as follows:—

The production of duramen takes place in consequence of the elements of the wood becoming filled by derivatives of the solid woody substance; these products being formed to some extent in the part which becomes indurated, and partly in neighbouring portions of the wood; by this means the extent of duramen is increased. These substances must originally be fluid and rich in tannin; but the cells contain also other substances which give to the duramen its great power of resistance. Nitric acid or "macerating fluid," and then potash- or soda-ley, remove most of these substances, except in the case of *Diospyros*. If the induration is carried on sufficiently long, the cell-walls are also partially destroyed, and the products of decomposition mingled with the contents. The composition of the substances contained in the duramen varies with the species; that of the Amygdaleæ, for example, contains gum (?), of the coniferæ resin, of *Syringa* resinous substances. The purpose of the duramen, at least in the lower parts of the branches, is to furnish a protection for the sound wood against the influence of atmospheric agents.

History of Assimilation and of the Functions of Chlorophyll.†—A. Hansen gives a list of the researches and conclusions on this subject from the days of Ingenhousz, Senebier, and Hales. The first scientific explanation of the phenomena he considers to be that of Sachs, between the years 1862 and 1865, that the starch in the chlorophyll-grains is a product of the living chlorophyll, and is produced in the chlorophyll by its power of assimilation. The author criticizes unfavourably the views of Pringsheim with regard to the nature, mode of formation, and functions of hypochlorin.

Theoretical View of the Process of Assimilation.‡—In his investigations on the chemical constitution of protoplasm,§ J. Reinke was led to frame a hypothesis as to the immediate products of the reduction of carbonic acid. He points out that this gas, CO_3H_2, may be subjected to three degrees of deoxidation. By the removal of one combining proportion of oxygen it becomes formic acid, CO_2H_2, which he states is always formed in every vegetable cell. The second stage of deoxidation reduces it to formic aldehyde, COH_2, a remarkably

* SB. K. Akad. Wiss. Wien, lxxxv. (1882). See Bot. Centralbl., x. (1882) p. 163.

† Hansen, A., 'Geschichte der Assimilation u. Chlorophyllfunction,' 90 pp. Leipzig, 1882. Also Arbeit Bot. Inst. Würzburg, ii. (1882) pp. 537–626.

‡ Bot. Ztg., xl. (1882) pp. 289–97, 305–14.

§ See this Journal, *ante*, pp. 361–2.

polymeric substance, two of its isomers being oxymethylen, $C_3H_6O_3$, and glucose, $C_6H_{12}O_6$. The result of complete deoxidation is the production of methylene, CH_2, a substance which cannot itself exist independently, but which again has a very large number of isomeric hydrocarbons, as diamylene, $C_{10}H_{20}$, triamylene, $C_{15}H_{30}$, and tetramylene, $C_{20}H_{40}$; the highest members of this series being solid and crystallizable.

With this process of reduction is associated a process of oxidation in the chlorophyll-grains, and the resulting products are derived from the balance of these two processes. The most common stage of reduction reached is that of formic aldehyde.

Reinke believes that this hypothesis is in harmony with that of Pringsheim regarding the formation of hypochlorin. A portion of the formic aldehyde is reduced to the hydrocarbon condition; and the hypochlorin results from a condensation of such groups. Passing from the reducing region of the chlorophyll-grain to the respiring portion of the cell, it is there oxidized into the volatile fatty acids. Both formic aldehyde and hypochlorin are very readily oxidizable, and require the protection of the chlorophyll to prevent their oxidation.

First Products of Assimilation.* — A. Mori has performed a fresh series of experiments, chiefly on *Spirogyra*, which confirm his previous conclusion that the first product of assimilation in chlorophyllaceous plants is an aldehyde, probably formic aldehyde, formed according to the following equation out of the elements of carbonic anhydride and water:—$CH_2O_3 = CH_2O + O_2$.

Absorption of Metallic Oxides by Plants.†—Mr. F. C. Phillips says that the question how far the vital processes of plants are influenced by the various mineral compounds presented by the soil to their roots has long been under discussion, but further than to establish the fact that the presence of certain compounds in the soil tends to increase the nutritious elements and promote the growth of particular plants, little has been done towards a complete solution of the problem.

It is well known that potash tends to increase the quantity of starch, that silica strengthens the stems of the grasses, that oxide of iron is essential to the production of leaf-green, and that phosphates increase the fertility of the soil for cereals, but even as regards these constant elements of every soil, very little can be positively asserted of the precise influence of any one, in the economy of the plant.

Concerning the part played by the rarer elements, cæsium, rubidium, copper, nickel, manganese, zinc, and barium, in the assimilation of carbon, nitrogen, and the functions of nutrition, and whether they are beneficial or injurious, nothing whatever is known, although modern refinements in chemical methods have led to their frequent detection both in soil and in plants. That so important a problem

* Nuov. Giorn. Bot. Ital., xiv. (1882) pp. 147–55. Cf. this Journal, *ante*, p. 361.

† Journ. Franklin Institute, cxiv. (1882) pp. 41–9.

should have remained almost wholly unsolved must be attributed chiefly to the very great difficulties which are met in any experimental investigation, but also to the fact that the few investigations published have been carried out, in most cases, for the purpose of proving that vegetation had been injured by metallic compounds traceable to metallurgical works, and with the special purpose of founding a claim for damages, rather than to solve a scientific problem. The study of the influence of metallic compounds on plants has recently acquired great practical importance, from the fact that many manufacturing processes, more especially those employed in the smelting of lead and copper, and arsenical ores of various metals, have given rise to a gradual impregnation of the soil with such metals, and to the consequent poisoning of vegetation and animals.

The possibility of injury to plants has been denied on the assumption that they select such elements of the soil as are nutritious and reject all else.

Mr. Phillips has therefore undertaken experiments from which it seems safe to conclude: 1. That healthy plants grown under favourable conditions may absorb, through their roots, small quantities of lead, zinc, copper, and arsenic. 2. That lead and zinc may enter the tissues in this way without causing any disturbance in the growth, nutrition, and functions of the plant. 3. That the compounds of copper and arsenic exert a distinctly poisonous influence, tending, when present in larger quantity, to check the formation of roots, and either killing the plant or so far reducing its vitality as to interfere with nutrition and growth. In the case of the heavy metals, copper, zinc, arsenic, and lead, it seems to be probable that their oxides may under certain circumstances become deposited in the tissues of the plant. As to the manner in which this takes place, authorities differ.

It is supposed by Freytag and others, that plants absorb all soluble matters indiscriminately, through their numberless rootlets; that the absorption of poisonous metals causes no disturbance until a certain degree of concentration is reached, when the plant rapidly withers and dies; that plants are therefore spared the sufferings of chronic poisoning, but are very susceptible to acute poisoning, which is invariably fatal; while it is held by others that plants absorb only such elements as are essential and nutritious, refusing to take up what is poisonous or innutritious; metallic compounds found in the analyses are therefore to be traced to atmospheric deposit adhering externally. The theory of Freytag seems to the author to have the weight of facts in its favour, and if it is possible that crops may become charged in this way with poisonous elements of the soil, it becomes a matter of the highest importance that wherever there is danger of such impregnation the most efficient means be employed for its aversion; for soil once impregnated with copper, lead, and zinc, may year after year bear crops poisoned in the same manner.

Decomposition of Calcium carbonate in the Stem of Dicotyledonous Woods.*—H. Molisch states that the deposition of calcium

* SB. K. Akad. Wiss. Wien, lxxxiv. (1881). See Bot. Centralbl., x. (1882) p. 161.

carbonate in the wood of dicotyledonous trees is not a rare phenomenon; but that it takes place only in the duramen or in parts of the alburnum which resemble the duramen in properties. In knots and wounded parts it is frequently separated in considerable quantities. It is deposited especially in the vessels and tracheides, less often in the libriform, parenchyma, and medullary rays. It occurs abundantly in the pith when the wood that is in immediate proximity to it assumes the nature of duramen, and becomes filled with lime. An account is given of the different woods in which calcium carbonate was found.

Hypochlorin.*—The investigations of Pringsheim † on the nature and mode of formation of hypochlorin have been gone over by A. B. Frank, with the following results:—

The hypochlorin reaction is found by Frank to bear the most intimate relation to the presence of the colouring matter of chlorophyll; and this connection is the only constant one, there being no relation to the presence or absence of conditions of assimilation. Hypochlorin is never present in any other part of the protoplasm than in that which is coloured by the chlorophyll-pigment, and here it appears to be universal, whether the chlorophyll be in the form of grains or spiral bands or in the amorphous condition. The hypochlorin reaction manifests itself along with the very first trace of the green colour in the young protoplasm, as was demonstrated in terminal buds of *Elodea canadensis*, where the cells of the young minute leaves are still in a merismatic condition, long before the differentiation of the chlorophyll into grains, and when it is improbable that any assimilation can take place. Hypochlorin is also found in the cell till the close of the existence of the chlorophyll-pigment, in conditions which exclude the possibility of assimilation.

The hypochlorin reaction is invariably accompanied by a destruction of the colouring matter of the chlorophyll. The first effects of acids on chlorophyll-grains is a change of the green colour into yellowish green or yellow, and this is followed by the separation of oily drops of hypochlorin. If, however, the cells are killed, no separation of hypochlorin takes place.

Two conditions are therefore necessary for the separation of hypochlorin:—the living condition of the chlorophyll-grain, and the presence of an acid. The reaction may be induced by hydrochloric, sulphuric, nitric, phosphoric, acetic, lactic, tartaric, citric, picric, or salicylic acid, and with very various degrees of concentration. The cause of the change of colour of leaves in autumn is the disappearance of the protoplasm from the cells, in consequence of which the chlorophyll-grains come into contact with the acid cell-sap. The same changes take place when leaves become yellow from want of light. The author believes that in this case the chlorophyll is not destroyed directly by the want of light, but only by the secondary action of the acid cell-sap in consequence of the destruction of the protoplasm.

* SB. Bot. Ver. Prov. Brandenburg, xxiii. (1822) pp. 11–16.
† See this Journal, iii. (1880) pp. 117, 480; i. (1881) p. 479.

In a different communication * J. Wiesner states his general concurrence with Frank's conclusion, which he would carry somewhat further. From its impermeability to organic acids, Wiesner regards protoplasm as having for one of its functions the protection of chlorophyll from injury from this source. The same process takes place also in fruits as in leaves.

Latex of Euphorbia Lathyris.†—An elaborate examination of the latex of *Euphorbia Lathyris* has led J. Schullerus to the conclusion that it must be regarded neither as a product of excretion (waste product) nor as a reserve material, but as a substance of actual direct service to the nutrition of the plant. The following are some of the special results at which he has arrived :—

The laticiferous tubes of this plant originate even in the embryo, and exclusively in the cells contiguous to the cortical parenchyma; no laticiferous cells being formed at a later period or originating in any other way. They are found during the whole life of the plant, and in all its parts, in the root as well as the aerial portion. They may branch, but do not anastomose, either in the nodes or leaves. The growth of these tubes does not depend on that of contiguous cells, but is independent of them and may even be restricted by their growth; they retain, during their existence, their power of apical growth and of branching at any spot. The latex of *E. Lathyris* is a formative sap, taking part directly in the processes of growth of the plant, and cannot be regarded as a mere reserve material. Its nutritive properties are proportionate to the amount of carbohydrate, especially starch, contained in it. When in an inactive condition it passes over to the state of a primordial latex. This is also the function of the latex of the permanent rhizomes of *Euphorbia palustris*, *orientalis*, *Pithyusa*, and *trigonocarpa*, rich in albuminoids, but containing but little carbohydrate. The absence of this property of storing up reserve materials distinguishes the laticiferous vessels physiologically from the cortical parenchyma. Besides osmotic movement, the latex possesses also a power of movement in mass, corresponding to the general movement of food-materials towards those parts where new formations are taking place, not due in any way to external influences.

These facts regarding the physiological function of the latex of *E. Lathyris* are true also for that of other species of *Euphorbia* which do not differ from it by any very strongly marked characters.

Darwin's so-called "Brain-function" of the Tips of Roots.‡—E. Detlefsen has investigated in a series of fresh experiments, the peculiar properties attributed by Darwin § to the extreme tips of

* Bot. Centralbl., x. (1882) pp. 260–6.

† SB. Bot. Ver. Prov. Brandenburg, xxiii. (1882) pp. 26–93.

‡ Arbeit. Bot. Inst. Würzburg, ii. (1882) pp. 627–47.

§ "It is hardly an exaggeration to say that the tip of the radicle thus endowed, and having the power of directing the movements of the adjoining parts, acts like the brain of one of the lower animals; the brain being seated within the anterior end of the body, receiving impressions from the sense-organs, and directing the several movements."—Darwin, *The Power of Movement in Plants*, p. 573.

roots, and has come to the conclusion that his statement of these properties cannot in all respects be substantiated. He states that the curvatures manifested by the roots when a foreign body is applied to them on one side, and which Darwin attributes to the sensibility of the roots, are really due to injury suffered by the root from the cutting off of free access of air, all the tissues being found to be destroyed up to the cylinder of plerome. That the cause of the curvature is injury to the root-sap is shown by parallel experiments in which the injury is inflicted in other ways.

The statement of Darwin that it is only the apex of the root that is susceptible is also contested. Experiments with roots from which the tip had been entirely removed, showed the same geotropic phenomena as others in which the roots were entire.

The author further disputes Darwin's assertion that the apices alone of roots are susceptible to change in the degree of moisture of the environment; he states, on the contrary, that the whole of the growing part of the root, and not merely the tip, is affected by an unequal degree of moisture in the surrounding air, curving in the direction in which the air is most moist.

Aerial Cultivation of Aquatic Plants.*—E. Mer records the results of a series of experiments for the purpose of determining the effects produced by growing in the air plants which ordinarily grow entirely submerged in water. They were placed in a vessel of water in such a way that the buds were above the surface of the water, and the whole covered with a bell-glass; others being, at the same time, grown under similar vessels entirely in water. The sun, in July, was powerful during the whole of the experiments.

In *Potamogeton natans* and *rufescens* the shoots grown in the air were distinguished from the normal ones by the shortness of their internodes, the smallness of the leaves, which partially remained rudimentary, and the presence of numerous stomata, which were also found, but in small numbers, in the newly formed branches of the submerged specimens. The formation of stomata is ascribed by the author to the retardation of growth and to heredity. The accumulation of reserve-materials in the tissue resulting from the retardation may bring about divisions in the epidermal cells, and hence lead to the formation of stomata. The formation of stomata only in the parts exposed to air he attributes to more vigorous transpiration. Similar causes lead to the formation of stomata on the perianth-leaves of *P. rufescens* and the foliage-leaves of *Littorella lacustris*. Hereditary tendency causes the localization of the stomata on the upper side of the leaves in *P. natans*, as is usual in floating leaves; it also produces the effect in *Littorella* that, when grown in the air, the newly formed leaves possess a larger or smaller number of stomata, according as the plants grew originally at a greater or less depth below the surface of the water.

In *Hydrocharis morsus ranæ* the size of the leaves was greatly diminished, as well as the length of the leaf-stalk, the intercellular

* Comptes Rendus, xciv. (1882) pp. 175–8.

spaces and epidermal cells were smaller, and the latter had somewhat wavy outlines. In *Nuphar pumilum* the leaves were smaller and contained less starch.

The author concludes that the incapacity of certain water plants to produce branches outside the water depends on their inability to resist strong transpiration, and not on any incapacity to grow and nourish themselves in the air. They thrive in the air if it is only sufficiently moist to reduce transpiration to a small amount.

Insectivorous Plants.*—A. F. W. Schimper gives detailed descriptions of several insectivorous plants, natives of North America. In the first place, the structure is more fully described than heretofore of the ascidiform leaves of *Sarracenia purpurea*. It was clearly determined that the products of decomposition of the insects and other organic substances found in the pitchers enter the cells of the leaf, as is shown by the changes which take place in the protoplasm of the cells thus affected. In these cells Schimper noticed a phenomenon closely resembling that described by Darwin as occurring in *Drosera* under the name "aggregation of protoplasm." In fact, however, in *Sarracenia*, the aggregations consist of a concentrated solution of tannin, which substance is always present in the cell-sap.

There occur in North America three species of *Utricularia*, land-plants growing in moist sandy situations. Of these *U. cornuta* was especially examined, and presents several very singular points of structure. The plant possesses no true root, the rhizome branching into several root-like organs, which bear the bladders in great quantities, and which the author believes to be homologous to the floating leaves of the aquatic species. The bladders are similar in form to those of *U. vulgaris*, but want the "antennæ," as is also their histological structure, which is described in detail. They contain, besides inorganic bodies, small animals and Algæ, especially diatoms, rotifers, and crustacea; the animals were never found alive, but usually much swollen and decomposed, and this was also the case with the diatoms, the contents of the bladders being apparently poisonous to both animals and plants. The hairs of the bladders appear to act as organs of absorption; and in the contents of their cells similar changes were observed to those described in the cases of *Sarracenia* and *Drosera*. As in *Dionæa*, an excess of nutriment is injurious to the plant.

Climbing Plants.†—In opposition to the view of Von Mohl, S. Schwendener denies the existence of a special faculty of irritability to which the twining of climbing stems and tendrils is due. He considers all the phenomena of these organs to be explicable by the laws of circumnutation and of geotropism.

Power of Movement in Plants.‡—In J. Wiesner's work on this subject he goes through the results published by Darwin in his work

* Bot. Ztg., xl. (1882) pp. 225–34, 241–8 (1 pl.).

† SB. Bot. Ver. Prov. Brandenburg, xxiii. (1882) pp. 9–11.

‡ Wiesner, J., 'Das Bewegungsvermögen der Pflanzen,' 212 pp., Vienna, 1881. See Bot. Ztg., xl. (1882) pp. 202–8. See also 'Nature,' xxv. (1882) pp. 578–82; 597–601.

bearing the same title, and in a great many points comes to a more or less different conclusion, his arguments being in all cases founded on actual experiments. The following are some of the more important points in which he differs from Darwin.

As regards circumnutation, Wiesner doubts its existence in roots, attributing this apparent phenomenon to the antagonism between geotropism and the natural tendency to curvature existing in roots, first one and then the other of these forces getting the upper hand, and thus moving the tip of the root backwards and forwards. In the case of stems, also, he considers that there are some plants which do not exhibit circumnutation. Some leaves also, he states, grow in absolutely straight lines without circumnutating, the apparent circumnutation being here again due to the varying action of opposing forces, viz. epinasty, apogeotropism, apheliotropism, and gravitation.

Wiesner's explanation of heliotropism agrees with that of De Candolle, that the convex side grows more quickly simply because it is in shade.

The author disputes the value of Darwin's experiments which are alleged to prove the sensitiveness of the tips of radicles, attributing the observed phenomena to injury resulting from the means employed.

Electrical Researches on Plant Forms.*—The absorption of water by porous bodies is accompanied by electric currents. When a porous earthenware cell is partly filled with water, and a current completed through a galvanometer by means of electrodes in the water and in contact with the outer wall of the cell, a current passes. The intensity continually diminishes, until it finally ceases, and then a current begins in the opposite direction from the cell-wall through the water. This reversal of current is due to the incomplete state of saturation of the walls of the cell. These phenomena are employed by A. J. Kunkel to account for various electric phenomena observed in plants.

In regard to the electromotive action of the upper surface of green leaves, the difference of tension of the various parts was determined by a systematic method of contact over the whole surface, with the result that the leaf-veins are generally positive towards the rest of the leaf, but the direction of the current is reversed if the spot on the leaf where the electrode is placed is wetted before the other electrode is placed on the vein. Also a spot long moistened is positive towards one freshly wetted. When the electrodes rest on the epidermis of a plant and a wound is made near the electrode, then that electrode will be negative to the other. The same result is obtained by bending the plant, and the current formed is the more intense the greater the amount of bending, the electrode near the bend being negative to the other. Sometimes plants also show the existence of electric currents, which when the plant moves cause the galvanometer needle to oscillate.

* Bied. Centr., 1882, pp. 28–30. Cf. Journ. Chem. Soc. Abstr., xlii. (1882) p. 638.

Electromotive Properties of the Leaf of Dionæa.*—Professor J. Burdon Sanderson has investigated the immediate and subsequent electrical results of excitation of the leaf of *Dionæa*, which have previously been examined by Munk, Kunkel, and the author himself.

It is found that at the moment of excitation (whether mechanical or electrical) the under surface of the lobe of the leaf is electro-negative to the upper surface, the difference of potential reaching its maximum about half a second after excitation; it then rapidly decreases until the upper surface is ultimately electro-negative to the lower, and this after-effect remains constant for some time. With a current not much more than adequate, excitation occurs at the moment of closing the current, but none occurs on breaking the circuit unless the current be sufficiently strong. The author considers (1) that the difference of potential is due to the electromotive forces which reside in the living protoplasm of parenchyma-cells in contact with one another, and in different states of physiological activity; (2) that the second phase of excitation is probably dependent on the diminution of turgescence of the excited cells, arising from a migration of liquid; (3) this explanation cannot be accepted for the phenomena of the first phase, the sudden accession and rapid propagation of which show that it is probably analogous to the "negative variation" or "action current" of animal physiology.

Influence of a Galvanic Current on Growing Roots.†—F. Elfving has observed the effect of a continuous current of electricity upon the growing organs of plants, especially roots, and finds that it causes a distinct curvature of the organ in the direction of the positive pole. This curvature has not, however, any physiological significance, like those due to geotropism and heliotropism; it is due to the retarding effect on growth of the current of electricity, especially on that side of the organ which the current meets directly.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Schizæaceæ.‡—The second part of Prantl's work on the Vascular Cryptogams is devoted to this group of ferns, and especially to the morphology of the non-sexual generation.

The first section is occupied with the arrangement of the leaves on the stem and the structure of the leaves and stem. There occur both radial and dorsiventral stems, the most remarkable among the latter being *Lygodium*, which has a single dorsal row of leaves, this arrangement originating even in the growing point. A similar structure occurs also in other ferns.

The genus *Lygodium* is also of special interest with respect to the structure of the sporangia. Each sporangium is here enclosed in a pocket, the upper wall of which is composed of the surface of the leaf

* Proc. Roy. Soc., xxxiii. (1882) pp. 148–51.

† Bot. Ztg., xl. (1882) pp. 257–64; 273–8.

‡ Prantl, K., 'Unters. zur Morphologie der Gefässkryptogamen. Heft ii. Die Schizæaceen.' Leipzig, 1881.

itself, while the lower wall is a lamella of tissue springing from the outer part of a vein. The sporangium springs, as in *Anemia*, from the margin of the leaf, while behind the sporangium is formed an annular wall, the indusium, which encloses the sporangium like a hood, the sporangium becoming eventually placed, in the course of development, on the under side of the leaf. Such a sporangium, covered by an indusium, is termed by the author a "monangic" sorus.

The apex of the young leaves is occupied by a wedge-shaped apical cell. In the finer veins the structure of the vascular bundles is collateral. No spiral vessels occur in the stem, and the sieve-tubes are very small. The mesophyll does not possess any true palisade-parenchyma, and is very nearly alike on the two sides of the leaf. The epidermis is not sharply separated from the fundamental tissue. In *Anemia* and *Schizœa* the cuticle is provided with siliceous warts. In *Anemia elegans* the stomata occur only on the upper side of the leaf. Those of *Schizœa* are arranged in two longitudinal rows on each side of the veins.

As regards classification, Prantl divides the Filices into three primary groups, viz. (1) Hymenophyllaceæ, Polypodiaceæ, and Cyatheaceæ; (2) Schizæaceæ, Gleicheniaceæ, and Parkeriaceæ; and (3) Osmundaceæ, Ophioglossaceæ, and Marattiaceæ. *Ceratopteris* he treats as belonging to the Schizæaceæ; it has monangic sori, as also has *Botrychium*. The author regards the Schizæaceæ as presenting the closest affinity among ferns to flowering plants. He inclines to the view that the nucellus of the ovule is homologous to the sporangium, and the entire ovule to a monangic sorus with its indusium.

Muscineæ.

Branched Sporogonium of a Moss.*—C. Fehlner describes an instance of branched sporogonium in *Meesea uliginosa*. From a common seta spring two sporangia, each with normal operculum and peristome. The capsule of *Meesea* not being regular, but laterally symmetrical owing to a curvature, the two sporangia are placed back to back in the same plane of symmetry, and the mutual pressure causes the surfaces which are in contact with one another to be somewhat flattened.

Leitgeb regards this and similar recorded cases of branched sporogonium as indicating reversion towards earlier forms of Archegoniatæ in which the sporogenous generation is normally branched. He states that they do not result from the archegonium containing two oospheres, or from coalescence of two embryos, but from vertical segmentation of the apical cell of the embryo, which therefore branches when it has attained a certain stage of development.

Influence of Light on the Thallus of Marchantia.†—A. Zimmermann contests Pfeffer's statement that the development of root-hairs from the gemmæ of *Marchantia* is determined only by contact with the surface of the soil; he finds, on the contrary, that in addition

* Oesterr. Bot. Zeitschr., xxxii. (1882) p. 185.
† Arbeit. Bot. Inst. Würzburg, ii. (1882) pp. 665–9.

to this contact and to gravitation, the absence of light is also a factor in determining on which side of the thallus the root-hairs shall be produced. Precisely the same results were obtained with gemmæ of *Lunularia*. The author confirms, on the other hand, the assertion of Pfeffer that the organic upper side of the thallus of *Marchantia* is always the side which faces the light. This was determined by cultivating the thallus both of *Marchantia* and *Lunularia* on the surface of water. He considers these observations to have an important bearing on those of Leitgeb and Prantl * on the bilateralness of the prothallium of ferns.

Goebel's Muscineæ.†—In his most recent account of the Muscineæ, Dr. K. Goebel introduces no fresh element into the main principle of their classification. The Hepaticæ are divided into two main groups, the Marchantiaceæ (subdivided into the Riccieæ, Corsinieæ, and Marchantieæ) and the Jungermanniaceæ (Jungermannieæ and Anthoceroteæ). In the Musci he groups the Sphagnaceæ and Andreaceæ together as one type, the Phascaceæ and Bryineæ together as a second type. In each group the various organs are treated in succession:—Firstly, the vegetative organs and the non-sexual mode of reproduction; then the sexual organs, and the development and structure of the second generation, ending with the structure and germination of the spores. A new instance of vegetative budding is described from the calyptra.

In their genetic relationship, Goebel regards the Hepaticæ and Musci as two offshoots from the same stem, the lowest Hepaticæ presenting the nearest resemblance to the original stock. They may possibly have sprung from the Thallophytes through *Coleochæte*, the hibernating oospore of which presents no great diversity from the sporogonium of *Riccia*. In the ascending scale the Muscineæ have no derivative forms, the series ending with them.

Characeæ.

Development of the Cortex in Chara.‡—T. F. Allen employs the mode of development of the cortex as a new basis for the classification of the species of *Chara*, and distinguishes the following eight methods:—

1. Some species never develope cortex-tubes, and the stems remain naked (*C. coronata* Ziz.).

2. Some species develope a single cortex-tube, which is so small that it does not join the one from the next leaf (*C. inconnexa* Allen).

3. Some cortex-nodes develope spines, but no secondary tubes; the primary tubes join and completely encircle the stem (*C. crinita* Wallr.).

4. Some cortex-tubes show a partial development of secondary tubes (*C. evoluta* Allen).

* See this Journal, ii. (1879) p. 917; iii. (1880) p. 121.

† Goebel, K., 'Die Muscineæ.' Encyklopædie der Naturwissenschaften, 1te Abtheil. 28 Lief. pp. 315–401.

‡ Bull. Torrey Bot. Club, ix. (1882) pp. 37–47 (8 pl.).

5. Some cortex-tubes develope one secondary cell only, which becomes as long as the primary cell, but is of smaller diameter (*C. excelsa* Allen, *C. intermedia* A. Br., *C. contraria* A. Br. Sect. Tylacanthæ).

6. Some develope only one lateral cortex-cell, which becomes larger than the primary cell and partially covers it, so that the primary cell seems to lie in a furrow (*C. fœtida* A. Br. Sect. Aulacanthæ).

7. Some cortex-cells develope perfectly one lateral cell, and imperfectly another (*C. aspera* Willd.).

8. Some cortex-cells develope perfectly both lateral cells, so that three complete series of cells arise from each leaf (*C. fragilis* Desv., *C. gymnopus* A. Br.).

Details of the application of these characters are followed by full descriptions of the following new American species:—*C. inconnexa*, *evoluta*, and *excelsa*.

Fungi.

Ustilagineæ.*—The fifth part of De Bary and Woronin's 'Morphology and Physiology of Fungi' is occupied by a treatise on the Ustilagineæ by M. Woronin.

The first section consists of a complete life-history of *Tuburcinia Trientalis* Berk. and Br., which attacks the stem, leaves, and rhizome of *Trientalis europœa*. The mycelium consists of sparingly septated and irregularly branched hyphæ which permeate the intercellular spaces, and put out haustorial lateral branches into the cells themselves of the host; these branches, with their short irregular secondary branches, having somewhat the form of a bunch of grapes. On this mycelium are produced two kinds of reproductive organ, conidia and resting-spores. The conidia are always borne on the under side of the leaves of the host, and form a white mould-like coating, the *Ascomyces Trientalis* of Berk. The hyphæ on which they are borne form a more or less dense felt between the epidermis and the mesophyll; lateral branches then penetrate through the stomata or between the walls of the epidermal cells, and bear the pear-shaped conidia, either first putting out haustoria or not. The conidia germinate readily in water, putting out a germinating filament, which either at once developes a conidiophore, or continues to grow without putting out conidia. Conidial hyphæ are also produced by sowing conidia on moistened leaves of *Trientalis*. These give rise to small patches of mycelium, on which the resting-spores are developed.

The resting-spores form brown *Sorosporium*-like masses, dusky patches $\frac{1}{2}$–2 mm. in diameter, on the leaves and leaf-stalk of the host. These spores are produced on much-branched mycelial filaments, which appear usually to be of smaller diameter than the purely vegetative ones, to be more freely septated, and usually destitute of haustoria. In their youngest stage they have the form of straight or curved, spiral or twisted branches, either singly or in coalescent

* De Bary, A., u. Woronin, M., 'Beiträge zur Morph. u. Phys. der Pilze,' Part v. 35 pp. (4 pls.), 4to, Frankfurt a. M., 1882.

pairs. These become septated, and some or all of the cells become vesicular. Soon a number of these hyphæ amalgamate into a dense ball, the vesicular cells at the same time increasing in size. In this way is formed a fructification, the interior of which is composed of the spores, polyhedral cells with ultimately thick and brown walls, comparatively large and numerous (as many as 100). The filamentous envelope of hyphæ ultimately gelatinizes and disappears. The process agrees in essential points with that in *Sorosporium Saponariæ*. The resting-spores do not remain dormant through the winter, but germinate late in the autumn of the same year on the host, each of the spores germinating separately. The process corresponds to that in *Tilletia*, each spore putting out a promycelium, which forms at its apex a cluster of cylindrical-fusiform sporidia in groups of from four to eight. While they are being formed the protoplasm leaves the basal part of the promycelium, and becomes separated by a septum from the empty portion, the promycelium thus becoming bicellular. The sporidia are abstricted from the terminal cell, which Woronin calls the basidial cell, and compares with the basidium of the Basidiomycetes. Unlike *Tilletia*, it becomes completely detached from the other cells. Two sporidia frequently anastomose, a process which Woronin regards as one of conjugation. One of the conjugating sporidia developes at its apex a secondary fusiform sporidium; but this also takes place in those which do not conjugate. They may even produce tertiary sporidia. After the sporidia have become detached, the basal cell, if still containing protoplasm, may put out a germinating tube. The sporidia and conidia bear no resemblance to one another in form. The sporidia are carried to the ground by rain or dew, and in this form again reach the leaves or stem of the host, which they penetrate with their mycelia.

In the second section, the author describes the mode of germination of the spores of other species of Ustilagineæ, which frequently differs in minor points from that of *Tuburcinia*, viz.:—*Sorosporium Saponariæ*, *Tolyposporium Junci*, *Thecaphora hyalina*, *Entyloma Aschersonii*, *E. Magnusii*, and *Melanotænium endogenum*.

In the third section these results are compared, and the group classified according to the mode of germination, as follows:—

I. No sporidia are formed in germination.

a. The spores put out long and copiously septated germinating filaments, which either are unbranched or the upper protoplasmic cell puts out lateral irregularly distributed branches. The terminal cell sometimes becomes detached, and carries on an independent existence—*Sorosporium*.

b. The growth of the germinating filaments is limited, and they form a promycelium. They are septated, but instead of producing sporidia, put out filaments, which usually grow in opposite directions, and which conjugate at their apices, then developing the true germinating filament—*Thecaphora*.

II. The promycelium is septated into a number of cells, from each of which is abstricted one or more sporidia:—*Ustilago-Schizonella* (*S. melogramma* DC.), *Tolyposporium*.

III. At the apex of the promycelium is formed a whorl of from two to eight usually fusiform branches, also termed sporidia, which usually conjugate in pairs, developing finally into secondary sporidia or directly into long, slender, simple or branched germinating filaments:—*Tilletia*, *Entyloma*, *Melanotænium*, *Schroeteria*, *Urocystis*, *Tuburcinia*.

The following species, nearly allied to *Tuburcinia*, are also specially described:—*Thecaphora aterrima* Tul., *Sorosporium schizocaulon* Ces., *S. Müllerianum* Thüm., *Urocystis Paridis* Thüm. (*Sorosporium Paridis* Wint., *Polycystis opaca* Strauss, *Urocystis Colchici* f. *Paridis* F. v. Waldh.), *Tuburcinia Veronicæ* Schröt., *T. Cesati* Sor., *T. scabies* Berk.

Unobserved Sensitiveness in Phycomyces.*—F. Elfving has observed that if a moist disk of gypsum is brought near to growing *Phycomyces*, the sporangiophores will lose their upright growth and bend in various directions; and this will take place even if the atmosphere is saturated with aqueous vapour. The author suggests that the phenomenon is due to contact electricity.

Beltrania, a New Genus of Hyphomycetes.†—Under the name *Beltrania rhombica* O. Penzig describes a hyphomycetous fungus constituting a new generic type, found on the under side of fallen lemon leaves in Sicily, on which it forms an olive-coloured velvety coating. It presents most affinity to *Fusicladium* and *Scolecotrichum*, but differs from them in having sterile filaments in addition to the sterigmata, and the bicellular beaked spores collected in clusters on short basidia. The following is the technical description of the genus:—

Cæspitulis hypophyllis, stratum fusco-olivaceum constituentibus; hyphis erectis vel adscendentibus, dense aggregatis, continuis vel 1–2-septatis, subsimplicibus, sinuosis; setulis sterilibus longioribus inter hyphas fertiles intermixtis; conidiis vel in hypharum apice sessilibus vel sterigmate ex apice oriundo suffultis, solitariis vel fasciculatis, 1-septatis, apice rostratis.

Chemical Composition of Moulds.‡—N. Sieber has prepared a growth of pure *Aspergillus*, *Mucor*, and *Penicillium*, the absence of Schizomycetes being assured by the presence of free phosphoric acid in the nutrient fluid. An analysis of the alcohol and ether extract, of which the exact composition is given, showed that it consisted entirely of albumen and cellulose. Further experiments show that the form of albuminoid present was not that of mycoprotein. A very small quantity of an undetermined substance crystallized out of the extract.

Salmon Disease.§—Professor T. H. Huxley, in his observations on this disease, not only examined the minute structure of both the healthy and diseased skin, but also tried some experiments on the

* Bot. Notiser, 1881. See Bot. Centralbl., x. (1882) p. 76.
† Nuov. Giorn. Bot. Ital., xiv. (1882) pp. 72–5 (1 pl.).
‡ Journ. f. prakt. Chem., xxiii. (1881) pp. 412–21.
§ Proc. Roy. Soc., xxxiii. (1882) pp. 381–9.

transplantation of the *Saprolegnia* of the living salmon to dead animal bodies.

The body of a recently killed common house-fly was gently rubbed two or three times over the surface of a patch of the diseased skin of a salmon, and was then placed in a vessel of water, on the surface of which it floated, in consequence of the large quantity of air which a fly's body contains. In the course of forty-eight hours, or thereabouts, innumerable white cottony filaments made their appearance, set close side by side, and radiated from the body of the fly in all directions. As these filaments had approximately the same length, the fly's body thus became enclosed in a thick white spheroidal shroud, having a diameter of as much as half an inch. As the filaments are specifically heavier than water, they gradually overcome the buoyancy of the air contained in the tracheæ of the fly, and the whole mass sinks to the bottom of the vessel. The filaments are very short when they are first discernible, and usually make their appearance where the integument of the fly is softest, as between the head and thorax, upon the proboscis, and between the rings of the abdomen. These filaments, in their size, structure, and the manner in which they give rise to zoo-sporangia and zoospores, are precisely similar to the hyphæ of the salmon fungus; and the characters of the one, as of the other, prove that the fungus is a *Saprolegnia* and not an *Achlya*. Moreover, it is easy to obtain evidence that the body of the fly has become infected by spores swept off by its surface when it was rubbed over the diseased skin. These spores have in fact germinated, and their hyphæ have perforated the cuticle of the fly, notwithstanding its comparative density, and have then ramified outwards and inwards, growing at the expense of the nourishment supplied by the tissues of the fly.

This experiment, which has been repeated with all needful checks, proves that the pathogenic *Saprolegnia* of the living salmon may become an ordinary saprogenic *Saprolegnia* ; and, *per contra*, that the latter may give rise to the former, and they lead to the important practical conclusion that the cause of salmon disease may exist in all waters in which dead insects, infested with *Saprolegnia*, are met with ; that is to say, probably in all the fresh waters of these islands, at one time or another.

On the other hand, *Saprolegnia* has never been observed on decaying bodies in salt water, and there is every reason to believe that as a saprophyte, it is confined to fresh waters.

Thus it becomes, to say the least, a highly probable conclusion that we must look for the origin of the disease to the *Saprolegniæ* which infest dead organic bodies in our fresh waters. Neither pollution, drought, nor overstocking will produce the disease if the *Saprolegnia* is absent. The most these conditions can do is to favour the development or the diffusion of the *materies morbi* where the *Saprolegnia* already exists.

The results of the last season's observations on the salmon disease appear to justify the following conclusions :—

1. That the *Saprolegnia* attacks the healthy living salmon exactly

in the same way as it attacks the dead insect, and that it is the sole cause of the disease, whatever circumstances may, in a secondary manner, assist its operations.

2. That death may result without any other organ than the skin being attacked, and that, under these circumstances, it is the consequence partly of the exhaustion of nervous energy by the incessant irritation of the felted mycelium with its charge of fine sand, and partly of the drain of nutriment directly and indirectly caused by the fungus.

3. That the penetration of the hyphæ of the *Saprolegnia* into the derma renders it at least possible that the disease may break out in a fresh-run salmon without re-infection.

4. That the cause of the disease, the *Saprolegnia*, may flourish in any fresh water, in the absence of salmon, as a saprophyte upon dead insects and other animals.

5. That the chances of infection for a healthy fish entering a river are prodigiously increased by the existence of diseased fish in that river, inasmuch as the bulk of *Saprolegnia* on a few diseased fish vastly exceeds that which would exist without them.

6. That as in the case of the potato disease, the careful extirpation of every diseased individual is the treatment theoretically indicated, though, in practice, it may not be worth while to adopt that treatment.

Formation of Saccharomyces in Nutrient Fluids containing various Proportions of Nitrogen.*—M. Hayduck finds asparagin especially well adapted as a source of nitrogen for *Saccharomyces.* The mineral ingredients of the nutrient fluid were a mixture of 50 g. acid potassium phosphate, PH_2KO_4 and 17 g. crystallized magnesium sulphate; and the following results were obtained:—

1. The nitrogen contained in a nutrient fluid is assimilated by the yeast only up to a certain degree of concentration; and above this limit the nitrogen is not used in the production of yeast. (2) In all the experiments an excretion of nitrogen was observed. (3) When formed in very dilute solutions the yeast contains a constant minimum proportion of nitrogen; as the proportion of nitrogen in the solution increases, the amount of yeast formed remains the same, while the proportion of nitrogen in it increases. But beyond a certain limit, the amount of nitrogen in the fluid increases neither the amount of yeast produced nor the proportion of nitrogen in it. (4) The fermenting power of the yeast depends partly on the proportion of nitrogen contained in it. (5) Yeast containing a large amount of nitrogen can increase in a pure solution of sugar, a portion of the nitrogenous contents of the mother-cells being used in the formation of the daughter-cells. (6) The growth of the yeast may be affected by the formation of one or more products of fermentation, alcohol especially exerting a prejudicial influence upon it.

* Zeitschr. f. Spiritusindustrie, 1881, p. 173. See Bot. Centralbl., x. (1882) p. 153.

Morphology and Genetic Relationship of Pathogenous Bacteria.* —Dr. T. Haberkorn thus sums up the results of a series of observations on this subject:—(1) The four tribes of Cohn, spherobacteria, microbacteria, desmobacteria, and spirobacteria, cannot be maintained; these being all forms of a single genus with numerous species. (2) The history of development of the bacteria of malaria, typhus, and acute contagium is essentially the same, including pleomorphy and a definite alternation of generations. (3) Each of these diseases is accompanied by a distinct species of bacterium; typhoid having also one of its own. (4) The various species of bacteria are distinguished by their conditions of existence, size, colour, habit, movements, and metastasis.

Pathogenous Bacteria.†—V. Babes has convinced himself that there are no bacteria in the blood or the tissues of healthy men; this judgment is based on the personal examination of more than one hundred bodies. He once observed the growth of filaments of *Bacillus anthracis* from spores in the sexual organs of a woman. Bacterian colonies, and not rods only, were observed in a case of *Anthrax intestinalis;* other examples of similar phenomena were observed, and weaken the generally accepted doctrine that rods alone are found in the living body. The author has for a long time used aniline green and aniline violet as colouring agents.

Bacterium of Charbon.‡—The temperature which seems most favourable to the bacterium of *charbon,* is that of mammalia (37° C.). Birds, having a higher temperature (about 42°), do not take the disease under ordinary conditions. Pasteur, however, has developed it in fowls by lowering the temperature (keeping the feet in cold water).

M. Gibier has now experimented with frogs, and finds that they do not suffer after inoculation in the normal state; but if kept, after being inoculated, in water at about 37°, they may take the disease (five out of twenty did—most of the others died soon after immersion). The bacteria developed were remarkable for their great length, and this is attributed to the slowness of the circulation.

Connection of Bacteria with Ferments.§—J. Rossbach finds that the death which ensues in one to two hours after the injection of papayotin into the rabbit is accompanied by the appearance of large quantities of bacteria in the blood. These were ascertained to be entirely absent before the injection; but introduction of as small quantities as 0·05 to 0·1 gramme of this substance resulted, after death, in the presence of a large number of moving globular and "hour-glass-shaped" bacteria in every drop of blood taken from the heart. Thus it appears that the presence of a small quantity of an unorganized and purely chemical substance is sufficient to produce in the body conditions which induce the rapid multiplication of microphytes already existing there in insignificant quantities. This

* Bot. Centralbl., x. (1882) pp. 100–6.
† Biol. Centralbl., ii. (1882) pp. 97–101.
‡ Comptes Rendus, xciv. (1882).
§ Medic. Centralbl., xx. (1882) p. 81. Cf. Naturforscher, xv. (1882) p. 224.

supports the view that chemical poisons or ferments play an important part in the injections connected with organic germs.

Lichenes.

Life-history of Cora.*—The genus *Cora*, established by Fries, has been regarded by some as belonging to Algæ, by others as belonging to Fungi, while Nylander, who detected the true fructification as consisting of apothecia and ascospores, maintained it to be a lichen. O. Mattirolo has carefully examined all the known species, and fully confirms Nylander's view.

In the thallus is a well-defined gonimic layer, the gonidia belonging to the genus *Chroococcus*. One species, *Cora ligulata* Kremp., must be erected into a distinct genus in which the gonidia have a *Scytonema*-form; Mattirolo proposes for it the name *Rhipidonema*. The author has not been able to confirm Nylander's account of the occurrence of apothecia, which probably belonged to a different lichen or fungus. Both *Cora* and *Rhipidonema* have on the under side a true hymenium, something like *Thelephora* or *Kneiffia*, formed of basidia which are the apices of special hyphæ. Each basidium bears a sterigma, on which is a single spherical spore, as in *Kneiffia*.

The author holds, therefore, that we have in these two genera lichens in the building up of which Basidiomycetes, and not Ascomycetes, have taken part. This new group he terms HYMENOLICHENES, and places them among the Basidiomycetes, near to *Kneiffia*, *Corticium*, *Stereum*, *Thelephora*, and *Hypochnus*. It includes the following species:—*Cora Pavonia*, *glabrata*, *gyrolophia*, and *Neesiana*, and *Rhipidonema ligulata*. They are all extra-European, and abundant in the tropics.

Minks's Licheno-mycological Symbols.†—In his last essay on the structure and affinity of lichens, Dr. A. Minks recapitulates the grounds of his microgonidial theory,‡ and recommends *Leptogium myochroum* as a specially favourable species for establishing the existence of microgonidia. The ascus of a lichen he regards as simply a highly differentiated hypha, the terminal cell of which has the power of dividing so as to produce the spores. Neither in the history of their development nor in their structure do the spores correspond to the ascospores of the true Ascomycetes; and their mode of germination is also different.

The portion already published of Dr. Minks's work includes descriptions of 170 species; and the whole family is intended to be gone through at the rate of about 200 species per annum.

Algæ.

Symbiosis of Algæ with Lower Animals.§—Since so many naturalists have published observations on this subject, Dr. G. Entz

* Nuov. Giorn. Bot. Ital., xiii. (1881) pp. 245–67 (2 pls.).

† Minks, A., 'Symbolæ licheno-mycologicæ,' Part I. Cassel, 1881.

‡ See this Journal, ii. (1879) pp. 311, 931.

§ Biol. Centralbl., i. (1881) p. 646. Cf. Naturforscher, xv. (1882) pp. 93–4, and this Journal, *ante*, p. 241.

takes occasion to call attention to some results of his own, published in Hungarian in 1876. From a study of the chlorophyll-bodies of Infusoria, he had come to the conclusion that their presence there was not distinctive of any special group of Infusoria. These bodies only occurred in omnivorous species; and those species in whom they occurred in abundance were noticed to take in no solid food, but only to agitate water in their œsophagus. He characterized these green bodies as Algæ, and stated their relation to their hosts as being a perpetual source of nutriment to the latter, which in their turn furnish them with a safe domicile; the Infusorian supplies the alga with carbonic acid, while the alga produces oxygen for its host. "We have thus to do in this case with a fellowship or peculiar consort relation between two totally different organisms, which may be compared in some respects to the organization of the lichens, which, according to Schwendener's interpretation, owe their existence to the association of a fungus with an alga." Entz has subsequently continued his study of this question, and has been able clearly to see a nucleus in these chlorophyll-bodies, and to determine that the mass is generally invested by a hyaline gelatinous envelope, and thus exhibits all the characteristics of the *Palmellaceæ*. He finds that the zoospores of various low Algæ and green Flagellates as well may become converted into these "pseudo-chlorophyll-bodies."

Division of the Cell-nucleus in Spirogyra.*—E. Tangl gives the following results of observations on an undetermined species of *Spirogyra*:—

1. The membrane of the cell-nucleus, when at rest, has a reticulate structure; but the author was unable to determine whether this was the result of local differences in density, or of actual perforation.

2. The nucleus contains, as a rule, only a single nucleolus, and includes, when at rest, besides the nucleolus, a finely granular mass, very poor in substance, and only slightly tinted by colouring reagents; the nucleolus is bounded by a membrane which is not tinted.

3. The nuclear spindle, the formation of which is preceded by demonstrable changes in the contents, is of the type described by Strasburger, and consists of equatorial rod-like elements which are not separated.

4. The portion of the original contents present in the "spindle-stage" of the nucleus, and only slightly tinted by reagents, is subsequently resorbed during the formation of the daughter-nuclei.

5. These facts appear to corroborate Strasburger's view that the spindle-fibres are derived from the protoplasm which is forced into the nucleus.

6. During the separation of the two halves of the nuclear plate a uniting tube is formed, proceeding from the membrane of the nucleus which is already perforated at the two poles at the "spindle-

* Anzeiger K. Akad. Wiss. Wien, March 30, 1882. See Bot. Centralbl., x. (1882) p. 189.

stage," and the enveloping membrane of the nucleolus, the inner surface of which is closely applied to the uniting threads.

7. This combining tube constitutes the lining of an internal cavity of the mother-cell, which is relatively very large at a certain stage of the division, and which is closed outwardly by the rudiments of the daughter-nuclei. The further behaviour of this tube corresponds to that of the uniting threads in the species described by Strasburger.

Batrachospermum.*—G. Arcangeli describes in detail several species of *Batrachospermum*, among them one new one, *B. Julianum*, found in thermal waters near Pisa. He describes the genus as presenting, in the same species, two modes of multiplication of cells, by segmentation and by gemmation. The former occurs in the terminal cell of the stem and of the primary branches, and is the mode by which these organs lengthen, also in the cortical branches; while the verticillate branches are formed and lengthen by gemmation. At a short distance from the terminal cell of the stem and of the primary branches, the rudiments of the verticillate branches make their appearance in the form of hemispherical protuberances, which separate themselves from the mother-cell by means of a tangential septum. *B. Julianum* differs from the other species in the mode of development of the female organ, presenting a considerable resemblance to that in *Nemalion;* and the author considers that it establishes an intimate relation between the mode of fertilization in *Batrachospermum* and in the Florideæ. Although the thermal water in which *B. Julianum* grows, produces also a species of *Chantransia*, he was unable to detect any genetic connection between these genera, as stated by Sirodot.

New Beggiatoa.†—A. Engler has observed the barren salt ground in the neighbourhood of the harbour at Kiel to be densely covered with the dusky white filaments of several species of *Beggiatoa*, especially *B. alba* Vauch. var. *marina* Cohn (*B. Œrstedii* Rabenh.). Attached to the legs of crabs in the deep water of the same harbour he finds a new species, not corresponding completely to any hitherto described, which he calls *Beggiatoa multiseptata*. Associated with it is another form, resembling *Cladothrix*, but not belonging to the Schizomycetes, which Engler regards as the type of a new genus, and names *Cladomyces Mœbiusii*. It must be placed near *Stigeoclonium*.

Vampyrella.‡—J. Klein attempts to answer the question whether this organism is animal or vegetable, and has for this purpose examined four species, three of them new, *Vampyrella variabilis*, *inermis*, and *pedata*. In the resting condition *Vampyrella* forms, according to the species, stalked or sessile capsules, attached to various fresh-water Algæ.

A more exact description is given of *V. variabilis*, which occurs in

* Nuov. Giorn. Bot. Ital., xiv. (1882) pp. 155–67 (2 pls.).
† SB. Bot. Ver. Prov. Brandenburg, xxiii. (1882) pp. 17–20.
‡ Bot. Ztg., xl. (1882) pp. 193–200, 209–17 (1 pl.).

the form of globular, ellipsoidal, or irregular cysts in the empty cells of fresh-water confervæ. When ripe the contents are reddish, orange-yellow, or bright red, including a dark spot. The endochrome subsequently escapes in two, four, or more masses, which, as they gradually escape from the cyst, are clothed at the edge with a fringe of cilia, the dark body remaining still enclosed within them. The escaped ciliated bodies must be regarded as zoospores, and are provided with pseudopodia, moving about slowly with an amœboid motion. When two meet, and their pseudopodia come into contact, they slowly coalesce, and this the author regards as a kind of conjugation. The resulting bodies appear to be of the nature of plasmodia, are endowed with a creeping motion, and may again coalesce. These larger bodies attach themselves to certain algæ, ultimately become encysted, and then again go through the same course of development. Those zoospores which do not conjugate also become eventually encysted. Attached to the conferva are also found cysts of the *Vampyrella* of a different kind, resting cysts which remain for a time in a dormant condition before any further development takes place.

Vampyrella pendula and *inermis* agree with *V. variabilis* in essential characters, while *V. pedata* differs in some important points, and may, perhaps, be the type of a distinct genus. It is found, like the two last species, attached to *Œdogonium;* its zoospores have neither cilia nor pseudopodia, but a long projecting colourless beak, which is in front during the motion of the body, and appears to guide its movement by bending in different directions, finally becoming encysted, apparently without conjugation. These bodies have been described by zoologists as rhizopods (*Hyalodiscus rubicundus* Hertwig and Lesser, and *Plakopus ruber* F. E. Schulze).

A full description follows of seven distinct species of the genus; and the author concludes, taking all the points of structure into consideration, that *Vampyrella* is most nearly allied to the Chytridiaceæ and Myxomycetes, and must be regarded as a plant; but that it exhibits in some respects a transitional character to the animal kingdom.

Schizophyceæ.*—W. Zopf has undertaken a fresh examination of the lowest forms of Algæ, with the special object of determining whether the filamentous forms Scytonemeæ, Oscillarieæ, &c., and the non-filamentous or Chroococcaceæ may be different stages of development of the same organism. Pure material was obtained by allowing the filaments of the alga under examination to creep along the wall of the vessel, and collect above the level of the water in tufts or pellicles. These were then cultivated in boiled water or on disks of porous clay, which had also been exposed to a high temperature, and placed in large glass vessels in moist boiled sand. The dead cells of water-plants, as *Lemna*, *Utricularia*, &c., and the shells of certain of the lower animals, like *Cypris*, were also used as nurseries for the filamentous Schizophyceæ, and in them the formation of chroococcaceous forms was especially well followed out.

* Bot. Centralbl., x. (1882) pp. 32–6.

The author describes in detail the development under these circumstances of nine different filamentous species; and arrives at the following general conclusions:—(1) That the relationship between the Schizophyceæ and the Schizomycetes is much closer than has hitherto been generally believed, confirming the classification adopted by Cohn and Sachs of including these two families in the same group of Schizophyta. (2) That a new impulse is thus given to the study of the Schizophyceæ. (3) That the formation of zooglœa is a more widely spread phenomenon than has hitherto been supposed, as is illustrated in Cienkowski's observations on *Ulothrix*, *Cylindrocapsa*, and *Glœothamnion*. The results obtained tend also to the conclusion that many other members of the group of Chroococcaceæ are merely stages of development of filamentous Schizophyceæ.

Motion of Diatoms.—Prof. Hamilton L. Smith considers * that Mr. C. M. Vorce's paper on this subject † is marked by careful, well-matured statements, and that the conclusions at which he has arrived are quite correct. He has not the least doubt that the diatoms are enveloped by a membrane, out of which the stipes, tubes, &c., are formed. "The movements, so curious and so varied, are yet connected with the structure of the frustule, and we must not ignore this in attempting to explain them, e. g. the *Nitzschiœ*, which have a continuous raphe, that is, without median nodule or break, move in the most lively manner, they are also long and slender; the stalked forms move when free, *Cocconema*, for example, in a long curve, *Gomphonema*, straight; the *Navicula* group move in straight lines, but not in so lively a manner as the *Nitzschiœ*. All these, except the last named, have a median nodule. The *Surirelleœ*, which have the raphe along the four expansions, or *alœ* (two for each valve), move more sluggishly, rolling over frequently, and the *Amphiproreœ* and other twisted forms rock or twist as mentioned by Mr. Vorce, while the circular forms, like *Coscinodiscus*, which have the raphe probably all round the margin of the cingulum or connecting zone and edge of the valve, do not move at all, or if so, very sluggishly. The movement then is more or less regulated by the structure of the frustule, and in any explanation we must not forget this. The careful observation of facts meanwhile should not be neglected, and the publication of them may give the clue or hint that will guide some other observer, possibly, to the true solution of a phenomenon as marvellous as it is at present inexplicable."

* Amer. Mon. Micr. Journ., iii. (1882) p. 85.
† See this Journal, *ante*, p. 394.

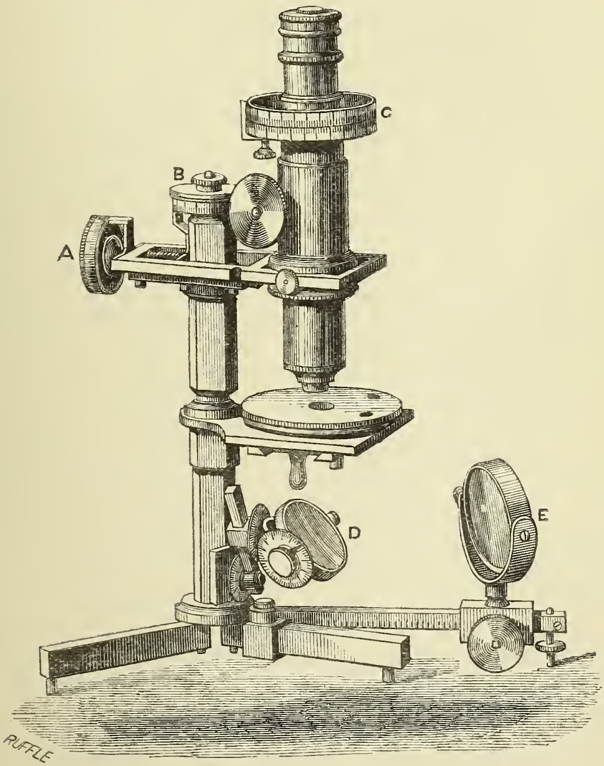
MICROSCOPY.

a. Instruments, Accessories, &c.

Lossner's Tele-microscope.*—O. M. Lossner has patented an instrument under this name. The objective forms a reduced image of a somewhat distant object, and this is enlarged by an ocular of four lenses. The construction of some is in hand, and "if successful this instrument, even if only for small enlargements, will, without doubt, be a welcome tool for the observation of living insects, &c."

Prazmowski's Micrometer Microscope. — This Microscope (Fig. 91) was designed by M. Prazmowski for investigations in

Fig. 91.



which measurements are to be recorded, and when it is also required to note precisely the angle of the illumination, &c., for purposes of repetition. We believe that it was made upon a special order (and not subsequently reclaimed), so that M. Prazmowski must not be

* Centr.-Ztg. f. Opt. u. Mech., iii. (1882) p. 108.

considered as endorsing any practical value in the instrument as a whole.

The principal micrometric movement is controlled by the graduated milled head A working on a fine steel screw against springs, by which the rectangular framework carrying the *optical body* is moved in a direction at right angles to the vertical main limb and parallel with the stage. The optical body, with rack and pinion for coarse adjustment, fits loosely into this carrier; it can be adjusted concentrically with the rotating stage by the action of side screws together with the micrometer-screw at A, and can be clamped in position by a screw-collar beneath. The fine-focussing is effected by the micrometer-head B working on a screw against a spiral spring on the main limb; the whole of the optical portion is thus moved together in focussing, as is usual in Continental Microscopes. The eye-piece has a goniometer circle C attached, and is provided with a movable disk of glass with crossed lines in the usual position of the eye-piece micrometer, by which accurate determinations of angles in azimuth can be made while the object is stationary, &c. The *rotating stage* is of simple construction, similar to that on ordinary "turntables"; it is held in position by an indented key-piece (metal knob shown under stage) that slides into a circular rotating groove beneath, and can be removed at pleasure—the main rectangular stage is then only $\frac{3}{16}$th inch in thickness, and is fitted with a wheel of diaphragms, also removable. The *mirror* D is mounted in a gimbal sliding on a bar with lateral motion; the three axes of motion are each provided with a graduated disk and pointer, so that exact record of the position can be made. The *condenser* E is mounted to slide on one of the feet, and can be adjusted variously to direct the light upon the mirror. The two back feet close up against the front one for convenience of packing.

Simplified Reading Microscope for horizontal and vertical circles.*—Herr Hensoldt, of Wetzlar, claims to have made a great improvement in the application of the compound Microscope to instruments of *medium* size, such as theodolites of from 12 to 20 cm. in diameter of limit. Whilst universally used for the larger, especially astronomical instruments, a Microscope has been found to be inconvenient for others, principally on account of the projecting micrometrical screws and the length of the body hitherto found necessary.

The author says that he "has succeeded in reducing the length of the Microscopes to a most considerable extent by the selection of favourable qualities of glass, and by suitable construction of the lenses. With a power of from 45 to 50 diameters, they only possess a length of 5 cm. and an outer diameter of 16 mm., reading up to 12″, and between the objective and the division there is sufficient room to affix a little illuminator, which throws a more than sufficient amount of light on the division. The latter appears very clear and distinct, and if the limb is provided with a glass cover, the objectives of the Microscopes are constructed accordingly, so as not to lose in definition.

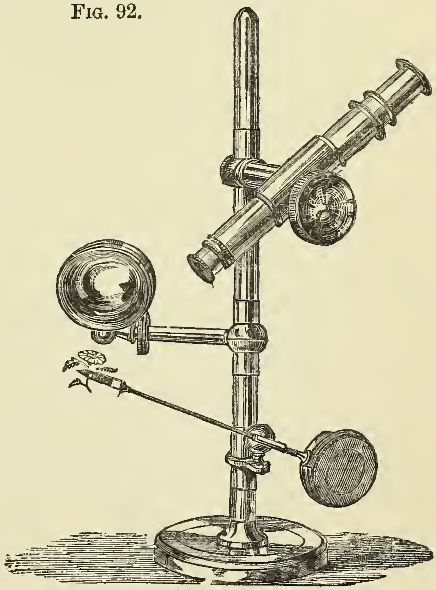
* Zeitschr. f. Vermessungswesen, viii. Transl. in Eng. Mech., xxxiv. (1881) pp. 83–4 (1 fig.).

"The Microscopes are provided with adjustable eye-pieces, to render the division of the micrometer distinct for every eyesight, and at the lower end is a short draw-tube, by means of which a small alteration in the magnification can be effected, whereby the intervals of the micrometer (previously determined by calculation) can be brought to accurately harmonize with the division of the circle.

"As the field of view, though as extensive as possible, cannot be so large as to always include figures of the divided circle, an index with a magnifying lens must be fixed at any desired point, by means of which the reading of the angle up to the nearest division of the circle is obtained, while the determination of the excess is effected by the Microscopes."

The divisions of the circle with which the Microscopes are used are not carried to any great degree of minuteness. The degrees are, for instance, divided into sixths, or 10′, and the micrometer consists of ten equal divisions, representing, therefore, minutes, and the latter can then be mentally subdivided with great facility. An important advantage is, the author considers, obtained by the *small number* of graduations of the micrometer, which permits an easy, rapid, and accurate reading, which does not occupy so much time as in the case of verniers.

Fig. 92.



Swift's Tank Microscope.—This, Fig. 92, consists of the stand of a bull's-eye condenser to which are attached two additional short arms, the upper one carrying the microscope-tube and the lower a revolving cork-holder and forceps for flowers or other objects suitable for low powers. The tube has a rack-and-pinion movement and the arm to which it is attached can be raised or lowered on the standard and clamped in any position. The tube can also be rotated on the arm so as to be either vertical or horizontal, or it can be removed from the arm altogether.

Teasdale's Field Naturalist's Microscope.—This (Figs. 93 and 94) was designed by Mr. W. Teasdale with the view of providing the working microscopist with a really cheap and efficient dissecting Microscope, and it may be readily certified that it fully accomplishes these objects. "It is so simply and substantially made that it

Fig. 93.

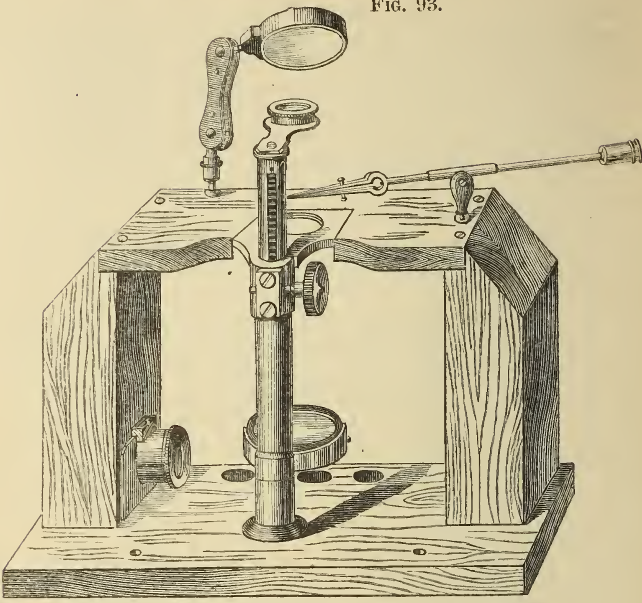
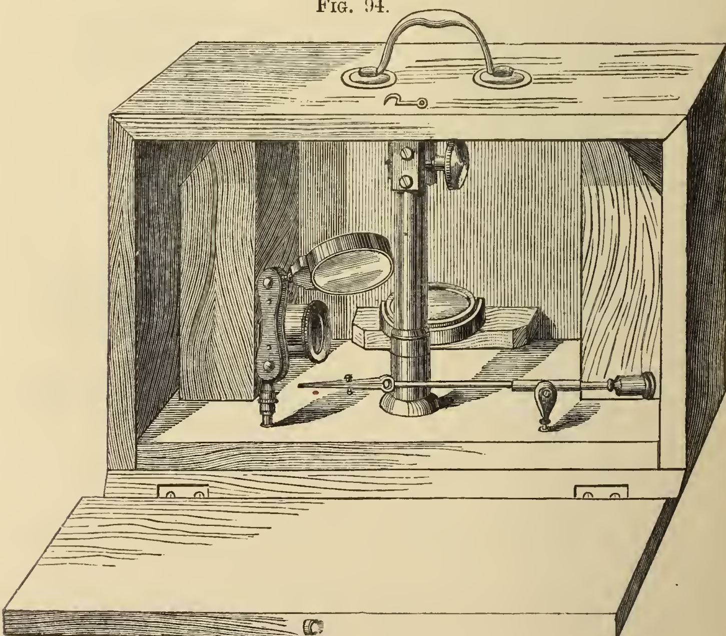


Fig. 94.



may be used by an intelligent child, as well as by the experienced microscopist. It was termed a 'Field Naturalist' rather than a 'Dissecting' Microscope to disarm the suspicion with which some people look upon an instrument with the latter name as a rack or means of torture for frogs, &c."

The woodcuts render any detailed description of the instrument unnecessary, and we need only call attention to the sloping rest for the hands and that there are three lenses, a condensing lens, forceps, and live-box. The lenses drop into the arm which carries them, and also into each other, so that they may be used in combination, producing seven powers in all.

Marshall's turntable can also be used with the instrument, the spindle passing through a hole in front of the stage, and its point revolving in a brass socket below.

Fig. 95.

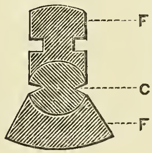
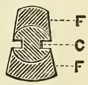


Fig. 96.



Steinheil's Achromatic Eye-pieces.—These eye-pieces ($\frac{3}{4}$ in. and $\frac{1}{3}$ in.), exhibited and described by Mr. Ingpen at the June meeting of the Society, are shown in Figs. 95 and 96 in section. They are especially adapted for micrometry. They consist of a double convex lens of crown between two meniscus lenses of flint, all cemented together. Grooves cut in the edge and blackened, form diaphragms as in the Coddington lens.

New Combination for Objectives.*—The following is the whole of the note by C. V. Zenger under this heading published in the 'Comptes Rendus':—

"The author proposes to obtain an amplification equal to 2000 with a large focal distance. It would then be possible for anatomists and physiologists to carry on their dissections and preparations with a very considerable amplification, at a distance from the objective equal to 4 mm. or 6 mm."

Fluid for Homogeneous Immersion.†—Professor Abbe finds that pure cedar-oil may be prepared so as to render it much less fluid than in its ordinary condition. By spreading it out in thin layers and exposing it for a long time to the influence of air and light, it becomes of the consistency of castor-oil, and without any increase in dispersive power, its refractive index is raised to 1·518–1·520. If desired, the index can of course be reduced to 1·510 by the addition of olive or castor oil.

Dr. L. Dippel considers that this fluid unites in itself *all* the properties required for such a fluid, and that it makes all others superfluous.

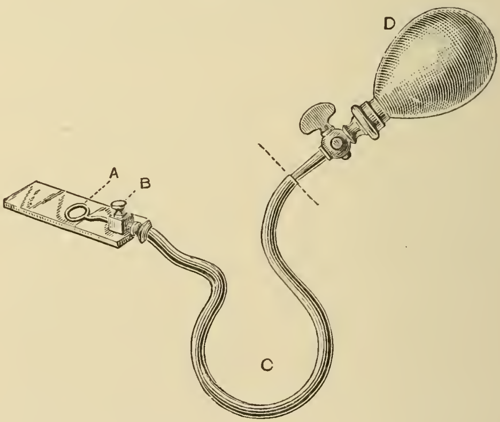
Shurley's Improved Slide for the Examination of Gaseous Matter.‡—Dr. E. L. Shurley describes an apparatus for the examina-

* Comptes Rendus, xciv. (1882) p. 1542.
† Bot. Centralbl., x. (1882) pp. 224–5.
‡ Proc. Amer. Soc. Micr., 4th Ann. Meeting, 1881, pp. 65–8 (1 fig.).

tion of aerial or gaseous material, with the higher power of objectives, without subjecting it to any previous manipulations, thus enabling one to collect and immediately examine with any objective, "even a $\frac{1}{25}$ or perhaps a $\frac{1}{50}$ inch." The apparatus consists of a rubber bag (Fig. 97) with a tapering, hard rubber nozzle, into which is inserted a perfectly tight fitting stopcock. A piece of soft rubber tubing $\frac{1}{8}$ inch in diameter and about 2 feet long is furnished at one end with a metal collar, to be inserted into the outer end of the brass canule of the slide; while the other is to be slipped over the nozzle of the bag. The larger extremity of a small canule about $1\frac{1}{2}$ inch long, is fixed by a binding screw into the upright B on the glass slide, while its small end is inserted into the minute hole at the side of the cell. The larger extremity is smoothly ground, to receive the metal-finished end of the conducting tube. The slide has an ordinary cell A (of rubber).

The cell has its middle portion built up from the bottom by a piece of glass, so as to bring it within the working distance of the objective, allowing depth enough at the sides, which may be compared to two ditches, for the introduction of a canule of reasonable

Fig. 97.



calibre. This, the author says, is an important point, inasmuch as a cell shallow enough for the adjustment of its bottom to the focus of a first-class $\frac{1}{8}$-inch objective, could have a depth of only about a fortieth of an inch, and of course for higher powers less, altogether too shallow to allow of the introduction of a canule of practicable size. But, upon this plan, the cell may be built up ever so much, even for adjustment of a $\frac{1}{50}$-inch objective, while yet at its sides will remain the same depth of ditches, or *sulci*, for the ingress of the gas.

The cover-glass may be cemented on, or laid on loosely. In the former case the opposite side of the cell must be perforated to allow

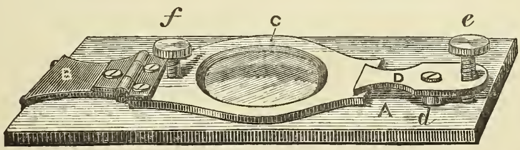
the gas to escape, while in the latter case it escapes by itself lifting up from time to time the cover-glass.

As all objects or particles contained in the air or gas must be at rest when examined with the higher power objectives, it will be necessary to coat either the bottom of the cell, the cover-glass, or both, with something to which the material will adhere as the gas passes through. One of the best methods is to coat both the bottom of the cell and under side of the cover-glass with a thin layer of glycerine—somewhat after Beale's method of collecting aerial germs. This coating is easily accomplished by previously moistening the glass with alcohol. The rubber bag and connecting-tube may be cleansed by drawing alcohol into them, and after expelling this they may be easily dried, if desired, by drawing and expelling air for awhile.

All the parts being in proper connection, by opening the stop-cock of the receiver, and gently pressing upon it, the cell may be supplied at will. As before stated, any gaseous material can be collected and kept any length of time from the access of air, and when desired, *directly* examined under the Microscope without any intermediate manipulation; "a great desideratum and one which cannot be attained so far as I have been able to learn, by any other slide or apparatus hitherto in use. Those most used are the 'Stricker' and 'Hunt' gas slides, the Holman 'life slide,' and the animalcule cell or cage, none of which is applicable in examinations with the higher power objectives; and none of which, excepting one, is arranged so as to allow of the direct introduction in small quantity of gaseous material. The advisability, nay, the necessity, of more perfect means for the examination of aerial or gaseous matter, must have been felt by every one who has ever attempted any work in this direction : and it is obviously only by patient investigation with high-power objectives that we can hope to discover the nature and habitat of those infinitesimal organic poisons which are supposed to originate in some unknown way the so-called zymotic diseases."

Hardy's Compressorium.*—Mr. J. D. Hardy's object in constructing the compressorium shown in Fig. 98, is to remedy, to some extent, the defects of existing compressors as regards the difficulty

FIG. 98.



of regulating the pressure with exactness, the imperfect parallelism, and a deficiency of freedom of action, which causes great risk of losing or damaging the object under observation.

* Journ. Quek. Micr. Club, i. (1882) pp. 35–6 (2 figs.).

A is a brass plate, 3 inches by $1\frac{1}{2}$ inch, in the centre of which is a round hole. At one end is a bent spring B, of thin brass, to which is hinged a second brass plate C, also with a central round hole, and bevelled on the upper surface for high powers. This second plate will, when turned down, overlie the plate A, and the two apertures will correspond. At the other end of the plate A, a button D is mounted so as to turn freely, and to rock on a short stud pin *d*. The outer extremity of this button is bored and tapped to receive a small thumb screw *e*. A similar thumb screw *f* is also fitted to the plate C, near its hinge joint.

A thin cover-glass is cemented to the upper side of the plate A, so as to cover the central hole, and the under side of the plate C is similarly provided.

The mode of using this compressor is as follows:—The plate C is first turned down into place, and the distance that it is desired the glasses should be apart roughly adjusted by means of the screw *f*. The plate C may then be turned back, and the object placed on the lower glass; the covering-plate is then again turned down and secured by turning the button D over it. By means of the two screws *d* and *f*, the pressure can now be regulated with the greatest nicety without any risk of damaging or losing the object under examination. The arrangement admits of the glasses being easily cleaned and readily replaced by new ones when broken.

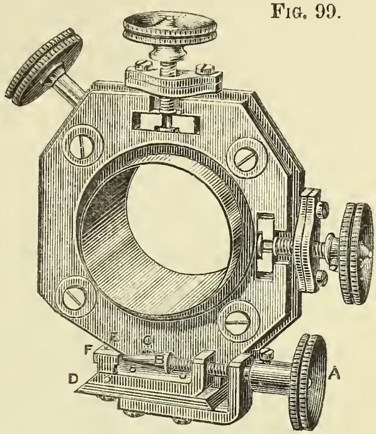
Bulloch's Diatom Stage.*—Mr. W. H. Bulloch has made a supplementary stage for use in arranging diatoms. It fits into the substage ring, and a stem projects up through the hole in the main stage. Upon the stem there is an arrangement like a double nose-piece, which carries two glass slips. One of the slips is intended for the material from which the diatoms are to be selected; the other for the prepared slide upon which they are to be mounted. The two slips can be moved about independently upon their supports. The hair or bristle is mounted on the mechanical stage. The slide carrying the material is first focussed, the diatom picked up, and the supplementary stage turned until the clean slide is in focus, when the diatom is placed in position.

Substage Fine-adjustment.—At the suggestion of Mr. E. M. Nelson, Messrs. Powell and Lealand have recently applied a fine-adjustment to their substage specially for use with their achromatic condenser. Fig. 99 shows (half-size) the under side of the substage with the new fine-adjustment in which A is a milled head controlling a screw-spindle terminating in a steel cone B. On rotating A, B turns and with a very slow motion forces up (or releases, as the case may be) a pin C inserted in the base-plate E of the substage. This motion of C carries with it the condenser. At right angles to, and forming part of E, at the back, an inner sliding plate works against a spring at the upper end between bearings F at each side, which are fixed upon the usual racked slide D of the substage; this inner

* Amer. Mon. Micr. Journ., iii. (1882) p. 97.

sliding plate is the essential addition to the usual racked slide in the application of the new fine-adjustment to the substage. The range of motion is about $\frac{1}{8}$ inch — the difference in radius between the smaller and larger ends of the steel cone.

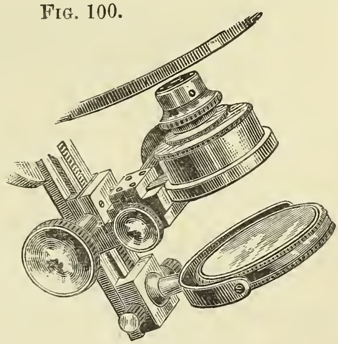
Fig. 99.



Mr. Nelson states that he has found the fine-adjustment on the substage of service in difficult investigations with the condenser in the axis. By this means he can readily exhibit the transverse lines of *A. pellucida* without any diaphragm.

Sidle's Centering Substage.—We gave a figure of Messrs. Sidle's "Iris" diaphragm in Vol. III. (1880) p. 1053, and briefly alluded to the centering arrangement of the substage as "a short bar working with a loosely fitting slot, that can be clamped beneath," which is characterized as a somewhat primitive contrivance. Messrs. Sidle now adopt in their "Acme No. 2 Binocular," the method of centering shown in Fig. 100, the special feature of which is that the substage motions are controlled by two milled heads (right and left) on the arm or bar-attachment at the back of the substage carrier, racking on the swinging tail-piece. By this system the usual *outer* substage-ring, with its projecting centering screws (so generally adopted in America), is done away with. The forward motion is given by the left-hand milled head acting on rackwork; the lateral motion by the right-hand milled head acting on a pointed screw against a U-shaped spring that presses the slide towards that side, the fixed end of the spring being attached to the main base- or angle-plate racking on the tail-piece.

Fig. 100.



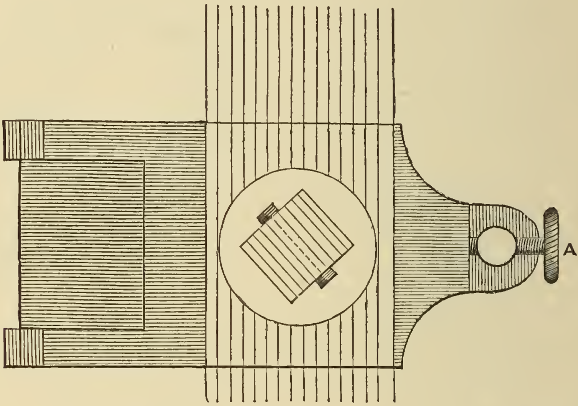
We have not yet seen this mechanism, but with good workmanship we should anticipate the plan to be practical—certainly much better than the former system of centering by the rough process of pushing, pulling, and clamping by hand, which did not suggest the possibility of accurate centering.

Mounting for the "Woodward" Prism.*—Dr. J. Edwards Smith recommends the form of mounting the "Woodward" prism shown in

* 'How to Work with the Microscope' (8vo, Chicago, 1880) p. 171 *et seq.*

Figs. 101 and 102 (where in Fig. 101 A is a vertical view, and in Fig. 102 B a sectional view, and C the prism three-fourths full size). He states that this accessory is easily placed in position in the well-hole of the "Acme" stand, and that doubtless with slight modifications this system of mounting the prism may be applicable to other Microscopes. Provision is made for centering in a lateral direction

Fig. 101.



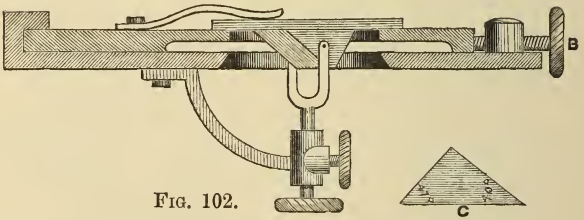


Fig. 102.

by means of the milled head at A. The prism can also be revolved by the milled head shown below so as to use either face, the faces being cut at different angles. Regarding the angles of the prism-faces, he thinks 98°, 41°, and 41°, as suggested by Dr. Woodward, are good; but that 93°, 47°, and 40°, which he has himself adopted, are especially adapted for the general run of modern wide-apertured objectives. He gives detailed instructions for the use of the apparatus and thinks that it "bids fair to come into general use."

Prisms versus the Hemispherical Lens as Illuminators.—In various catalogues issued by American opticians, references are also made to sundry forms of mounting for the "Woodward" prism. It appears to us that much ingenuity is being wasted in such efforts, for whatever may be the angles of the prism-faces, the hemispherical lens must necessarily entirely supersede it, having in fact an infinite number of facets through which normal light may reach the common centre. There may of course be cases where a small beam of parallel rays

directly transmitted by the plane prism-face may be thought to produce the purest effect of oblique illumination; but in our experience wherever oblique light is required for the resolution of striæ, &c., the slight condensation of rays produced by the curved surface of the hemispherical lens is no detriment, but rather the contrary, whilst for facility of manipulation the lens is greatly to be preferred.

Mounting the hemispherical lens on a plate to be put immediately beneath the slide is not to be commended, for every movement of the slide then carries the illuminator with it, and the direction of the light requires continual readjustment. No better plan of applying the lens has been suggested than that adopted by Tolles and Ross, in which it is mounted to slide or screw into the stage-aperture from beneath. This plan is applicable to nearly all the modern Microscopes having mechanical stages.

For the Microscopes generally used on the Continent, without mechanical stage-movements, the hemispherical lens may be mounted, as suggested by Professor Abbe, in a disk of metal made to drop into the stage-opening from above so that the plane face is flush with the level of the stage.

Radial Tail-pieces.—Since the introduction of the Zentmayer swinging tail-piece or swinging substage in 1876, several opticians have carried out the same principle, but instead of the pivot motion of Zentmayer a disk is applied at right angles behind the stage in which a movable zone is fitted to carry the tail-piece. In all the Microscopes we have inspected in which this plan is adopted, we remark that the attachment of the tail-piece is so slight as seriously to interfere with the firmness of the substage. This is a great inconvenience in all manipulations of the substage; the rackwork, centering-screws, diaphragms, mirror, or whatever may be attached to the tail-piece, cannot be touched whilst the eye is directed through the Microscope, without the flexure of the tail-piece causing the illumination to move from the field of view. Of course this applies only to the use of high powers, but all such Microscopes are supposed to be made specially for high-power work.

Electric Light in Microscopy.—Referring to his previous paper on this subject,* Dr. Van Heurck sends us the accompanying Fig. 103, showing the Regnier battery which he has adopted in place of the Tommasi; the sulphate of copper being placed in the small basket at the left-hand side of the cells.

The Regnier accumulator is also shown in Fig. 104.

Dr. Van Heurck adds that the Regnier battery can be placed in the laboratory of the microscopist, as it does not give off any vapours. It will remain charged for at least a month if sulphate of copper is added as required. Sixty-four Regnier elements (each = 1·07 volts), charging sixteen accumulators, lighted a great part of his house for six weeks. They can be used with only one accumulator, to act as a

* See this Journal, *ante*, pp. 418–20.

Fig. 103.

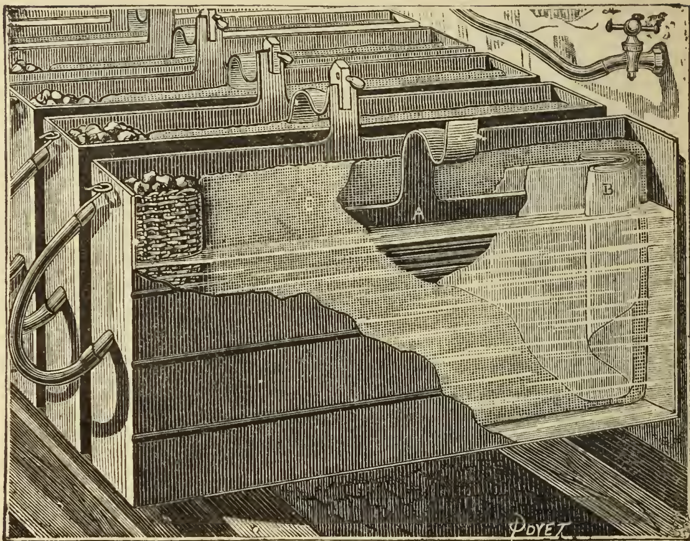
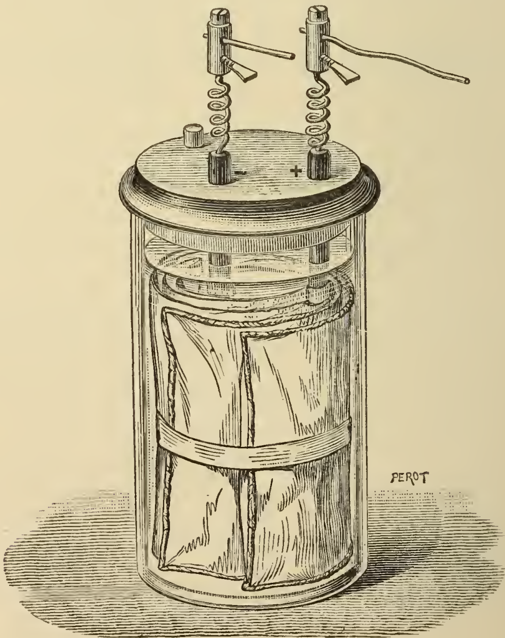


Fig. 104.



regulator of the current. If expense is not an object four accumulators may be used (requiring sixteen elements), the accumulators thus serving both as regulators and reservoirs, and allowing several lamps to be used at a time. The particular Swan lamps he uses are the "$2\frac{1}{2}$-candle" lamps.

Still later Dr. Van Heurck says that he is experimenting with some new accumulators of M. de Kabath, which seem likely to give good results.

Black Backgrounds.*—Mr. Tuffen West on principle very much dislikes to see objects mounted with an irremovable black background. When it is desirable to view objects as opaque, there are so many other ways of doing this; e. g. the diaphragm, the dark-well, a piece of dead-black paper, cloth, or velvet placed behind the slide. The object can then still be viewed as a transparent object also. Otherwise it is the mounter saying to the observer, "You shall see my slide as *I* will, and in no other way."

Micrometrical Measurement by means of Optical Images.†—A paper on this subject was published some time since by Professor Abbe in German, and we at once had it translated with a view to its insertion in this Journal. We must frankly confess, however, our inability to put the paper in proper form for publication here, and as Professor Abbe is much taxed in various ways we have not thought it right to ask him to undertake the matter.

We therefore content ourselves with a translation of a German abstract of the article.‡

"E. Abbe has turned his attention to the study of the Microscope as used with a micrometer, and finds that the sources of error belonging to the present methods of measurement can be obviated by using 'telescopic' systems of lenses instead of the ordinary objective with a finite focal distance. Such a glass is made up of two separate lenses or systems, whose focal planes are turned towards each other and coincide. It has an unlimited focal length, and the focal points lie at an infinite distance; all objects are reproduced with an enlargement which may be determined at will, but is constant; so that this magnification remains *independent alike of the distance of the object, that of the image, and of the length of the tube.*"

Malassez's Improved Compte-globules.—Professor L. Malassez in 1880 published§ a detailed paper on corpuscle-counters in which the various devices of himself, Hayem and Nachet, Gowers and Zeiss were fully referred to with a statement of their respective advantages and disadvantages, and in which he described an improved apparatus suggested by himself. An epitome of the paper by Mrs. Ernest Hart with critical observations has also appeared in English,|| so that it is unnecessary to refer to it otherwise than briefly here.

* Journ. Post. Micr. Soc., i. (1882) p. 94.
† SB. Jenaisch. Gesell. f. Med. u. Naturw., 1879, p. xi.
‡ Jahresber. (Virchow and Hirsch) for 1879, p. 27.
§ Arch. de Physiologie, 1880, p. 377.
|| Quart. Journ. Micr. Sci., xxi. (1881) pp. 132–45 (3 figs.).

The improved apparatus is shown in Fig. 105. It is made by M. Vérick, and consists of a thick brass slide, having in the centre an

Fig. 105.

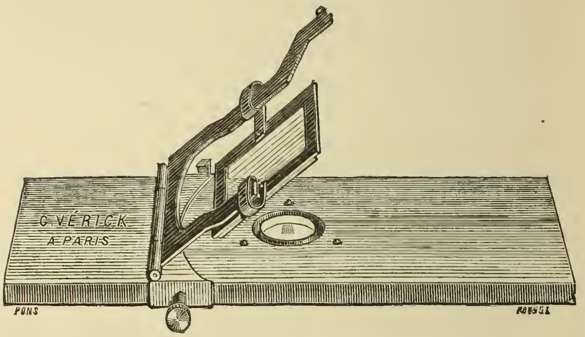
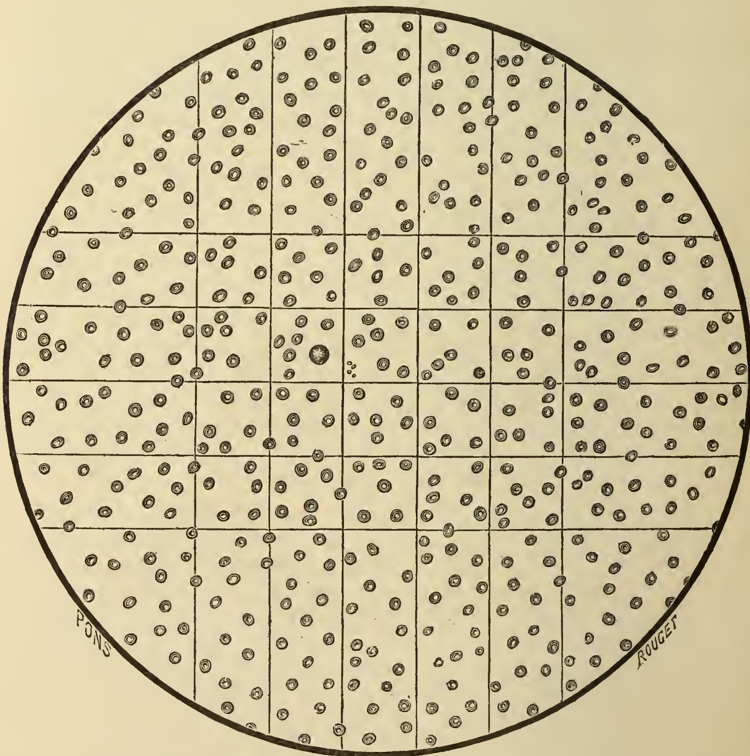


Fig. 106.

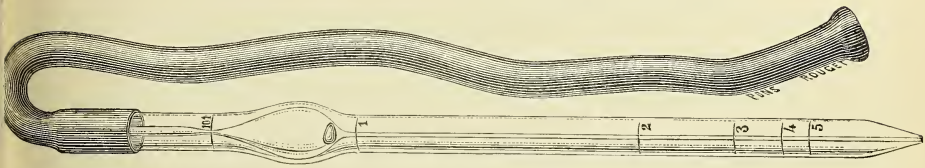


aperture, into which is fixed a circular glass block about a centimetre in diameter, with its upper surface level with the top of the slide, and

surrounded by a groove about half the thickness of the slide in depth. Outside this groove are three pointed metal screws equidistant from each other, the elevation of which above the surface of the slide is exactly $\frac{1}{5}$ mm. In the centre of the glass block the squares are drawn in which the corpuscles are counted. The sides of these are $\frac{1}{20}$ mm., and they are arranged in groups of twenty, as shown in Fig. 106 ($\times$ 200).

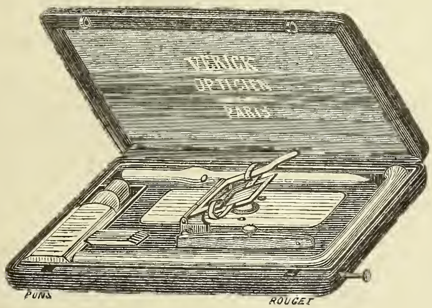
To facilitate lowering the cover-glass so as to be exactly horizontal, M. Malassez devised the frame (Fig. 105) to the underneath part of which the edges of the cover-glass are attached by a little water or saliva. The frame is supported on two arms attached to one flange of

Fig. 107.



a hinge, the other flange being secured to the slide by a clasping screw. The frame with the cover-glass is raised or lowered by the longer of the two arms, and the operation may be quickly performed. A small spring clip keeps the whole down so that there is no danger of the cover being raised or displaced.

Fig. 108.



The mixing of the blood is effected in the "Mélangeur Potain," shown in Fig. 107, and the whole apparatus, with triangular knife for making incisions, cover-glass, and a bottle of diluting liquid, packs into a small pocket-case $13 \cdot 5 \times 8 \times 2 \cdot 5$ cm. (Fig. 108).

ABBE, E.—The Relation of Aperture and Power in the Microscope.
This Journal, ii. (1882) pp. 300–9.
Engl. Mech., XXXV. (1882) pp. 374–5.

" Akakia."—Microscopy—Wide-angle Objectives.
Engl. Mech., XXXV. (1882) p. 283.

„ Microscope Power.
[Reply to " Antares," *infra*, as to the non-increase of aperture of some oil-immersion objectives over the figures shown with Abbe's Apertometer when water is used as the immersion fluid. An oil-immersion, if of only 1·25 N.A., will show that aperture with water, as it is below the maximum 1·33. Substituting oil cannot increase the reading, as the maximum aperture of the lens has been already measured.]
Engl. Mech., XXXV. (1882) pp. 309–10.

American Society of Microscopists.
[Review of 'Proceedings' of 4th Annual Meeting at Columbus, O.]
Amer. Natural., XVI. (1882) pp. 343–6.
[Circular of the President, Dr. G. E. Blackham, as to the Elmira Meeting in August 1882, and Letters from him and Dr. Up de Graff. Also circular as to proposed Quarterly Journal of Microscopy, &c.]
The Microscope, II. (1882) pp. 47–8, 85–7, 94.

" Antares."—Microscope Power.
[" Partial statement . . . of the details of magnifying power provided by an ordinary well-furnished instrument of full size."]
Engl. Mech., XXXV. (1882) pp. 261–2.

„ The Apertometer—Lantern Objectives.
[Reply approving of the explanation given in " Akakia's " letter, *supra*, and account of further experiments with objectives. Also remarks on the Apertometer and Aperture-measuring. A query to Mr. Shrubsole as to Lantern Objectives.]
Engl. Mech., XXXV. (1882) p. 429.

BALE, W. M.—On Recent Improvements in Microscopy.
[Deals with objectives, illuminating apparatus, stands, stages, swinging tail-pieces, this Journal, &c.]
Southern Science Record, II. (1882) pp. 75–80.

BEALE'S (L. S.) Microscope in Medicine. 4th ed.
[Review, with extended remarks on the germ theory of disease.]
Amer. Natural., XVI. (1882) pp. 500–4.

BOWMAN, F. H.—The Structure of the Cotton Fibre in its relation to Technical Applications. 2nd ed.
[Contains description of Microscope and Micrometers, pp. 7–14, and note on the " Limit of Microscopic Vision," p. 157.]
8vo, Manchester, 1882, xvi. and 211 pp. (5 figs. and 12 pls.).

BOYS, C. V.—Measurement of Curvature and Refractive Index.
Engl. Mech., XXXV. (1882) pp. 469–71, from 'Philosophical Magazine.'

BRADBURY, W.—The Achromatic Object-Glass. I.–VI.
[Deals with " the theoretical conditions that must be satisfied in the formation of an object-glass."]
Engl. Mech., XXXV. (1882) pp. 297–8, 344, 371–2, 393, 418–9, 440–1.

BRITTAIN, T.—The Beginnings of Microscopic Study.
[Brief general history of the simple and compound Microscope and Leuwenhoeck's observations.]
Field Naturalist, I. (1882) pp. 7–8.

BULLOCH, W. H.—Iris Diaphragm for Use above an Objective.
[Claims to have been the first to introduce it, and refers to his Catalogue of 1878.
J. W. Sidle subsequently writes referring to Dr. Royston-Pigott's previous description of such an apparatus.]
Amer. Mon. Micr. Journ., III. (1882) pp. 99, 117–8.

BULLOCH'S (W. H.) Apparatus for Measuring the Magnifying Power of Oculars. [*Post.*]
Amer. Mon. Micr. Journ., III. (1882) pp. 103–4 (1 fig.).
The Microscope, II. (1882) pp. 83–4.

Bulloch's (W. H.) Improvements in Microscopes. [*Supra*, p. 554.]
Amer. Mon. Micr. Journ., III. (1882) p. 97.

Chardonnet, de —.—Sur la transparence actinique des verres d'optique. (On the Actinic Transparency of Optical Glass.)
Comptes Rendus, XCIV. (1882) pp. 1468–70.

Chevalier, A.—L'Étudiant Micrographe. Traité théorique et pratique du Microscope et des préparations. (The Microscopical Student. Theoretical and practical treatise on the Microscope and preparations.) 3rd ed.
8vo, Paris, 1882, xvi. and 591 pp. (179 figs., 7 plates, and portrait).

Cole, A. C.—Studies in Microscopical Science. Vol. I.

No. 1 (pp. 1–8).—Yellow Fibro-Cartilage—Long. Vert. Sec. Pinna of Ear of Cow, double-stained in logwood and eosin. Plate × 333.

No. 2 (pp. 9–20).—Trans. Sec. Dicotyledonous Stem — Copper Beech (*Fagus cuprea*), stained carmine and iodine green. Plate × 25.

No. 3 (pp. 21–8).—Human Bone—Trans. Sec. Compact Tissue of Shaft of a Long Bone (Clavicle). Plate × 50.

No. 4 (pp. 29–32).—Trans. Sec. Monocotyledonous Stem — Umbrella Plant (*Cyperus alternifolius*)—Closed Fibro-Vascular Bundle, stained carmine and iodine green. Plate × 400.

No. 5 (pp. 33–40).—Human Skin — Vert. Sec. Sole of Foot, stained carmine and sulph-indigotate of soda. Plate × 65.

No. 6 (pp. 41–8).—Section of Pikrite (Inchcolm, Firth of Forth). Plate × 25.

No. 6*a* (pp. 49–64).—Same continued with Analytical Chart.

No. 7 (pp. 65–74).—Transverse Section of Spinal Cord of Cat—dorsal region. Plate × 20.

No. 8 (pp. 75–78).—Transverse Section of underground portion of Rachis of Frond of Bracken Fern (*Pteris aquilina*). Plate × 333.

No. 9 (pp. 79–86).—Vertical Section of Human Liver, stained logwood. Plate × 233·3.

No. 10 (pp. 87–92).—Transverse Section of Thallus of *Fucus vesiculosus* with Antheridia and Oogonia. Plate × 154.

No. 11 (pp. 93–102).—Vertical Section of Liver of Cat, injected (hepatic vein red, portal vein blue). Plate × 50.

No. 12 (pp. 103–8).—Transverse Vertical Section of a Leaf (*Rhododendron ponticum*), stained logwood. Plate × 333.

Reviewed in *Journ. of Sci.*, IV. (1882) pp. 374–5.
Sci.-Gossip, 1882, pp. 138, 160, and 186.
Knowledge, I. (1882) p. 609.
Nature, XXVI. (1882) p. 89.
North. Microscopist, II. (1882) pp. 163 and 193.
The Microscope, II. (1882) p. 93.

Cox, J. D.—Measurement of Microscopic Aperture.
[Abstr. of article, *ante*, p. 422.]
Amer. Natural., XVI. (1882) pp. 532–3.

Crisp, F.—Notes sur l'Ouverture, la vision microscopique et la valeur des objectifs à immersion à grand angle. (Notes on Aperture, Microscopical Vision, and the value of wide-angled Immersion Objectives)—*contd.*
[Transl. of paper I. (1881) pp. 303–60.]
Journ. de Microgr., VI. (1882) pp. 246–51 (2 figs.), 299–303 (6 figs.).

Crumbaugh, J. W.—The History of the Microscope and its Accessories, I. II.
The Microscope, II. (1882) pp. 33–8, 65–9.

Davis, G. E.—Practical Microscopy, 2nd ed.
8vo, London, 1882, viii. and 335 pp. (258 figs. and 1 pl.).
1st ed. reviewed in *Amer. Natural.*, XVI. (1882) pp. 432–3.
Nature, XXV. (1882) pp. 502–3.
Sci.-Gossip, 1882, p. 112.

" " The Limiting Diaphragm or Aperture Shutter.
[Comment on the statement, *ante* p. 407, that objectives of wide aperture cannot be made to do duty as narrow-angled ones also, so as to dispense with two classes of objectives.]
North. Microscopist, II. (1882) p. 194.

Deby, J., and F. Kitton.—A Bibliography of the Microscope and Micrographic Studies, being a catalogue of books and papers in the library of J. Deby. Part III. The Diatomaceæ. (Part 3 in advance of Parts 1 and 2.)
8vo, London (privately printed) 1882, 67 pp.

Dippel, L.—[Review of Dr. H. Van Heurck's paper on homogeneous-immersion objectives and fluids (cf. this Journal, *ante*, p. 264), preceded by a statement of his reasons for objecting, in opposition to Dr. Van Heurck, to correction-adjustments with such objectives. See also *supra*, p. 551.]
Bot. Centralbl., X. (1882) pp. 222–5.

Edmunds, J.—See Wenham, *infra*.

Engelmann, T. W.—Appareil Microspectral (Microspectroscopic Apparatus).
[For experiments on the disengagement of oxygen by vegetable cells, *post.*]
Rev. Internat. Sci. Biol., IX. (1882) pp. 465–7.

Falkinburg, W. S.—Hints to Amateur Microscopists.
[How to make a bull's-eye condenser from an old-fashioned bull's-eye watch-glass filled with glycerine and closed with plate glass.]
Amer. Mon. Micr. Journ., III. (1882) p. 92.

F.R.M.S. and "Another F.R.M.S."—See Wenham, *infra*.

Goltzsch, H.—Binoculares Mikroskop (Binocular Microscope). [*Post.*]
Zeitschr. f. Instrumentenk., II. (1882) pp. 225–6 (1 fig.),
from *Carl's Repertorium für Experimental-physik*, xviii. (1882) pp. 27–32.

Guillemare, —.—See Lutz, E.

Gundlach, E.—Oblique Illumination, with a special consideration of the capabilities of Immersion Condensers, and a note on Symmetrical Illumination.
[*Post.*]
Amer. Mon. Micr. Journ., III. (1882) pp. 85–8 (1 fig.).

Hall, L. B.—An Eye-protector for use with the Monocular Microscope.
[*Post.*]
The Microscope, II. (1882) pp. 88–90, from *Medical and Surgical Reports*.

Heurck, H. Van.—The Electric Light applied to Microscopical Research.
[Transl. of paper, *ante*, p. 418.]
North. Microscopist, II. (1882) pp. 141–7 (1 fig.).
See also *Rev. Mycologique* (1882) p. 199.

Hickin, —.—Microscopic Tank.
[Inquiry how to make a small tank for microscopic use (10 × 8 × 2), opaque ends and bottom.]
[Reply by J. A. Ollard—"crystallized dishes of about 7 inches diameter."]
Sci.-Gossip, 1882, pp. 142 and 160.

Hilgendorf, F.—Apparat für mikroskopische geometrische Zeichnungen. (Apparatus for Microscopical Geometrical Drawings.)
SB. Gesell. Nat. Fr. Berlin, 1882, pp. 58–60.

Hitchcock, R.—Numerical Aperture.
["A plain statement of what numerical aperture is."]
Amer. Mon. Micr. Journ., III. (1882) pp. 95–6.

" " The Microscope Trade.
[Protest against underselling.]
Amer. Mon. Micr. Journ., III. (1882) p. 97.

" " Newspaper Science.
[Quotations of "conglomerations of error and deliberate falsehood" in an article in the *Mechanical News* on the 'Power of the Microscope.']
Amer. Mon. Micr. Journ., III. (1882) p. 98.

J., T. R.—What is the meaning of the sign × ?
[Reply to E. Holmes, *ante*, p. 423, and insisting upon the correctness of his former view. "The idea of amplification alone does not cover the meaning of the sign × as used *microscopically* . . . . not algebraically or mechanically."]
Sci.-Gossip, 1882, p. 159.

Kitton, F.—See Deby, J.

LANCASTER, W. J.—See Sturt, T. J.

LANDSBERG, C.—Ueber den Antheil der Provinz Hannover an der Entwicklung der Feinmechanik. (On the Share of the Province of Hanover in the Development of Fine Mechanical Work.)

[The pages noted contain a correction of Harting's statement in 'Das Mikroskop,' that S. G. Hoffmann (who made Microscopes in the second half of the 18th century) was a Hanoverian—he in fact lived in Leipzig.]

Central-Ztg. f. Optik u. Mech., III. (1882) pp. 159–60 (foot-note).

LOSSNER, O. M.—Telemikroskop (Telemicroscope).

[Abstract of Patent—see *ante*, p. 424 and *supra*, p. 547.]

Centr.-Ztg. f. Opt. u. Mech., III. (1882) p. 108.

LOVETT, E.—Dark-ground Illumination.

[Incorrect heading—relates to white or porcelain backgrounds and slips of glass to be put under the slide, either of pale blue (for modifying the light), opal porcelain or china (for viewing dark objects as opaque, such as seeds), dull varnished on one side (for most opaque objects), or ground glass (for Foraminifera).]

Journ. Post. Micr. Soc., I. (1882) pp. 94–5.

LUTZ, E.—Microscope scolaire (School Microscope).

[Designed by Professor Guillemare, *post.*]

Journ. de Microgr., VI. (1882) pp. 233–5 (1 fig.).
See also *Rev. Mycologique*, IV. (1882) p. 199.

M'ALLISTER's (T. H.) Protector for Objectives.

[Copy of the Richards' Protector.]

Amer. Natural., XVI. (1882) p. 618 (2 figs.).

MERZ, S.—Ueber Dispersions-Verhältnisse optischer Gläser. (On the Dispersion Relations of Optical Glass.)

[Discussion of the best combinations of flint and crown glass to remove the secondary spectrum.]

Zeitschr. f. Instrumentenk., II. (1882) pp. 176–80.

Microscope by Culpepper and Scarlet, formerly in the possession of Sir A. Lever, exhibited and briefly described at meeting of Manchester Microscopical Society. *North. Microscopist*, II. (1882) p. 189.

MOORE, A. Y.—Something about Objectives. [*Post.*]

The Microscope, II. (1882) pp. 8–11.

MOSS, J. M.—See Wenham, *infra*.

Mounting Micro. Lens.

[Directions by W. J. Lancaster. See also *ante*, p. 424.]

Engl. Mech., XXXV. (1882) p. 335.

MUNRO, J. M. H.—Battery power for Swan Lamps.

[40 Grove cells were found to be necessary for 3 Swan lamps of 25 to 50 candle power—8 to 10 cells will probably be sufficient for lamps of 5 candle power.]

North. Microscopist, II. (1882) pp. 150–1, from *The Mechanical World*.

NELSON, E. M.—See Wenham, *infra*.

" " Tuberculosis.

[Contains reference to a $\frac{1}{25}$-inch oil-immersion objective 1·38 N.A. "specially constructed for me by Powell and Lealand for the purpose of investigating micro-organisms, and may fairly rank as the greatest achievement in the science of microscopical optics"—also to a fine adjustment to the substage of the Microscope which "will be found most useful by those engaged in observations with wide-angled high powers."]

Engl. Mech., XXXV. (1882) p. 378 (2 figs.).

OLLARD, J. A.—See Hickin.

" " Tadpole Slides.

[Description of Schultze's, *ante*, p. 110, and of the following. "Form a groove or cell on an ordinary slip of glass with folded blotting-paper

saturated with water; lay the tadpole in between on the glass, tail flat; cover the body over with saturated blotting-paper, the tail (if necessary) with thin glass. Keep the whole well saturated, and the tadpole will live for many exhibitions."]

Engl. Mech., XXXV. (1882) p. 284 (1 fig.).

Ollard, J. A.—The Microscopist's Companion.

[Description of a support for pocket lens with forceps and Forrest's Compressorium.]

Engl. Mech., XXXV. (1882) p. 330 (2 figs.).

Pelletan, J.—[Announcement of an intended publication of papers on (1) The theory of the Microscope; (2) The theory, construction, and use of Objectives; (3) Microscopes.]

Journ. de Microgr., VI. (1882) p. 206.
See also *Rev. Mycologique*, IV. (1882) p. 198.

Postal Microscopical Society's Journal.

[Notice of Nos. 1 and 2.]

Amer. Natural., XVI. (1882) p. 533.
Sci.-Gossip, 1882, p. 186.

President's Address.

[Abstract in part and note, "As a whole it is one of the best, most clear, sensible, and intelligible presidential addresses that it has been our good fortune to read for some time."]

Amer. Mon. Micr. Journ., III. (1882) pp. 106–11, 116.

Proctor, R. A.—The Eyes of Science.

[Deals principally with the extension of the power of human vision by photographic processes and methods—brief reference to the Telescope, Microscope, Spectroscope, &c.]

Knowledge, II. (1882) pp. 54–5.

Redding, T. B.—The Microscope: its revelations, with some of their bearings upon Christian Evidences.

Acton Lectures. 8vo, Indianapolis, 1881, pp. 129–48.

Reynier, E.—An Electric Battery for the Laboratory and Dwelling-house.

[Translation from *La Nature*, describing the battery mentioned *ante*, pp. 418–9.]

North. Microscopist, II. (1882) pp. 147–50.

Roumeguère, C.—Le Microscope populaire en Amérique. (Popular Microscopy in America.)

[Note as to the rapid progress made in the New World by micrography, with special reference to the Michigan University and Ann Arbor Soirées.]

Rev. Mycologique, IV. (1882) pp. 199–200.

Seibert, W.—Anwendung des Töpler'schen Schlieren-Apparates auf Mikroskope. (Use of the Töpler Apparatus in Microscopy.) [*Post.*]

Zeitschr. f. Instrumentenk., II. (1882) pp. 92–6 (3 figs.).
Abstr. in *Centr.-Ztg. f. Opt. u. Mech.*, III. (1882) p. 105 (2 figs.).

Sidle, J. W.—See Bulloch, W. H.

Sidle's Iris Diaphragms and "Acme" Stands.

[Brief description.]

North. Microscopist, II. (1882) pp. 190-1.

Steinheil's Eye-pieces. See this Journal, *supra*, p. 551.
Engl. Mech., XXXV. (1882) p. 458.

Stokes, A. W.—A Tadpole Slide.

[Objections to the plan of "Volvox" (*ante*, p. 438), as it prevents the use of a higher power than the ½ in.; it never ensures the tail lying flat from end to end, and the use of chloroform retards the circulation. Description of his own Tadpole Slide (*ante*, p. 110).]

Engl. Mech., XXXV. (1882) pp. 237–8 (1 fig.).

STOWELL, C. H. & L. R.—Editorial Notes.
[As to the first vol. of 'The Microscope'—Bausch and Lomb's "$\frac{1}{8}$ homogeneous," homogeneous-immersion condenser, mechanical finger and turntable, &c.—Arnold's Photomicrographs—Teichmann's Hæmin Crystals—Prof. A. Y. Moore's Resolution of "*Amphipleura pellucida* with a $\frac{1}{6}$ homogeneous by Central Sunlight"—Ward's Pigeon-post Films—&c.]
The Microscope, II. (1882) pp. 18–20.

[Elmira Meeting of the American Society of Microscopists—&c.]
The Microscope, II. (1882) pp. 50–4.

STURT, T. J.—Microscopic.
[As to using a bi-concave spectacle lens fitted to the draw-tube for table purposes, so that "a $\frac{2}{3}$ in. can be used to magnify to the same extent as a $\frac{1}{4}$ in."—also further query by "Handy-Man," and reply by W. J. Lancaster.]
Engl. Mech., XXXV. (1882) pp. 282–3, 339, 385.

THOMS, W. A., Election of. *Amer. Natural.*, XVI. (1882) p. 621.

WALE, G.—See Wenham, *infra*.

WEAD, C. K.—Studies with Micrometers.
[(1) Results of comparisons of Rogers' Micrometers and Fasoldt's test-plates. (2) On the effect of the cover-correction in changing the magnifying power. (3) Measuring the thickness of cover-glasses by the correction-collar, *post*.]
The Microscope, II. (1882) pp. 69–73.

WENHAM'S New Microscope.
[Further letters by F. H. Wenham, (2) J. M. Moss, Dr. J. Edmunds, and "Another F.R.M.S.," "F.R.M.S.," G. Wale, and E. M. Nelson, as to the priority of design.]
Engl. Mech., XXXV. (1882) pp. 282, 309, 330, 356, 356–7.

WIGAND, O.—Verbessertes Skioptikon (Improved Sciopticon). [*Post.*]
Centr.-Ztg. f. Opt. u. Mech., III. (1882) pp. 101–2 (1 fig.).

WOOSTER, W. H.—On an Impromptu Bramhall Reflector.
[The mirror removed from the Microscope and placed on the stage with the slide on it, condensing the light with the condenser.]
Journ. Micr. Soc. Victoria, I. (1882) pp. 100–1.

ZENGER, C. V.—Sur une nouvelle combinaison des lentilles du Microscope. (On a New Combination of Microscope Lenses.) [*Supra*, p. 551.]
Comptes Rendus, XCIV. (1882) p. 1542.

β. Collecting, Mounting and Examining Objects, &c.

Cutting and Mounting Microscopical Sections.*—Mr. A. G. Bourne describes some modifications of older processes, which he considers constitute the latest stage of development of the section-cutter's art.

Hardening.—Any of the ordinary hardening methods may be used, but it is essential that all trace of acid should be removed in order to obtain good staining results. Corrosive sublimate is an exceedingly useful hardening reagent, and tissue treated with it stains as readily as if treated with alcohol only. The solution used is a concentrated one. The fresh tissue or living animal is placed in it for fifteen to thirty minutes, according to its size; it is then washed in water and transferred to alcohol of 50 per cent.—a large relative bulk of this must be used, and the tissue well permeated by it, otherwise some

* Quart. Journ. Micr. Sci., xxii. (1882) pp. 334–7.

corrosive sublimate is left in the tissue and is thrown down in needles when strong alcohol is added. After 24 hours the tissue is transferred to alcohol of 70 per cent., and after 24 hours to alcohol of 90 per cent., and then to absolute alcohol. With large pieces of dense tissue this should be changed once or twice. After two or three days the tissue is ready for staining. If time is an object, and no acid has been used in the hardening, the tissue may be transferred directly from alcohol of 70 per cent. to the staining fluid; but it is advisable, and in the case of delicate tissues necessary, to complete the hardening process before staining.

Staining.—Grenacher's alcoholic borax carmine is used. Pure carmine (2·5 per cent.) is added to the solution of borax (4 per cent.), in water; this is allowed to stand for two or three days, and occasionally stirred—the greater part of the carmine will dissolve. To this solution is added an equal bulk of alcohol of 70 per cent. This mixture must stand for a week and then be filtered, when it is ready for use. If on keeping more carmine is deposited, it should be refiltered.

The tissue is placed in this solution, and allowed to remain one, two, or three days according to its size; it is hardly possible to overstain, and there is sufficient alcohol in the solution to prevent injury to any but the most delicate tissues. For such tissues a solution can be prepared containing more alcohol, but of course less carmine.

The tissue when removed from the staining fluid is placed in alcohol of 70 per cent., acidulated with hydrochloric acid (3 to 6 drops of the acid to 100 c.c. of spirit). This dissolves out all excess of carmine and fixes the rest. The tissue, a dark purplish-red when taken out of the borax carmine, should be left in the acidulated alcohol till it acquires a bright transparent look (3 to 6 hours), it may then be transferred to absolute alcohol and afterwards to turpentine. When thoroughly permeated with this latter (the time necessary varying as the size of the lump of tissue) it is ready for imbedding.

Imbedding.—This is done in paraffin, and it is exceedingly important to obtain a suitable paraffin. It should melt at 100° or 115° F. Paraffin of various melting points should be kept in the laboratory; they may be purchased at the dealers.

The tendency to curl up on the part of the section may be reduced to a minimum by obtaining a paraffin of the proper consistency, but this seems to vary according to the temperature of the room in which the sections are cut.

The paraffin must be melted in a small covered vessel in a water-oven, great care being taken to keep it in a dry atmosphere. The temperature in the oven should never rise more than two or three degrees above the melting point of the paraffin used.

When the paraffin is melted the tissue is removed from the turpentine and placed in it, and this must be kept at its melting point for some hours until the tissue is thoroughly permeated; it may then be poured into a paper trough, watch-glass, or any other vessel, and allowed to cool.

Cutting.—There are two forms of microtome suitable for cutting sections in series. In one the tissue is raised directly by a fine screw, and the sections cut with an ordinary razor: in the other form, now so largely used, the tissue in its holder is moved up an inclined plane, and the sections cut with a large knife which works backwards and forwards in a horizontal slot running parallel with the inclined plane. In both cases the machine is fixed to the table or heavy enough to remain steady, so that while the razor is worked with one hand the other hand is at liberty to hold a little paper spatula—a small piece of paper run on at the end of a small scalpel—to prevent the sections curling. The paraffin block is pared down to the smallest size possible, and, as the razor is drawn along, the edge, which commences to curl, is caught by the paper and prevented from so doing; the section is then transferred to the slide.

Preparation of the Slide.—The slide is smeared with a strong solution of shellac in anhydrous creosote. Care must be taken to have as little as possible on the slide. By this method the sections are stuck to the slide, thereby saving the most delicate objects from falling to pieces after the paraffin is removed, and enabling one to mount numerous sections on one slide. The importance and value of this treatment cannot be over-estimated. It enables one to mount with absolute certainty whole sections of the most friable objects, such as an insect, without a single fragment of the section becoming displaced.

Mounting.—The slide bearing the sections is now placed in a water-oven or on a tin box containing water at a temperature two or three degrees above the melting point of the paraffin used. The slide is left here for at least half an hour. The object of this warming is twofold, to evaporate the creosote and to melt the paraffin.

The slide is now taken up, and while the paraffin is still molten is flooded with turpentine dropped from a small pipette. This dissolves melted paraffin instantaneously, and precipitates the shellac fastening the sections to the slide. The turpentine is allowed to flow off, and replaced by new until all the paraffin is removed. The slide is then allowed to drain, the edges wiped, and the cover-glass put on. The Canada balsam, which should be very fluid, is placed on the under surface of the cover-glass; this is turned over and quickly lowered. The balsam dissolves the shellac, and if the cover-glass is not put on very quickly the sections may shift or delicate sections come to pieces and float off the slide. It being necessary to use the balsam in such a fluid condition, and a certain amount of turpentine always remaining upon the slide, the slides should be looked over the next day and more balsam added at the edge of the cover-glass if necessary. These methods, especially that of fastening the sections to the slide with shellac, although suggested and elaborated by zoologists for the purpose of mounting serial preparations, will, no doubt, come into very general use in ordinary histology for such tissues as placenta or spleen where very thin sections have always been found liable to fall to pieces, and the most important pieces to fall out and be lost.

Preparing Blastoderm of the Chick.—C. Koller,* who has taken up this subject in order to decide some disputed points in the embryology of the chick, thus describes the method by which his preparations were made.

The egg was subjected to the hatching method recommended by Kölliker. At the proper time it was opened and its contents carefully transferred to a glass; as much of the albumen as possible being removed by the fingers or otherwise. In order to keep a note of the exact direction in which it was wished to take the sections, it was generally found necessary to make an indication on the egg while still fresh, as in the earlier stages the appearances in the surface of the yolk are rendered indistinct by the process of hardening; to this end, Koller has been accustomed to insert with forceps a small triangular pointed slip of paper into the yolk immediately behind the germinal disk in such a way that it indicates the extreme posterior margin of the blastoderm, and lies at the same time in the median plane of the future embryo. The yolk is now submitted for twenty-four hours to the action of a $\frac{1}{10}$ per cent. solution of chromic acid, and then for another twenty-four hours to one of $\frac{1}{5}$ per cent., and thus increasing the strength daily up to $\frac{1}{2}$ per cent. If the yolk is sufficiently hardened, the segment on which the blastoderm lies, together with the central mass, is detached with a fine scalpel and immersed in distilled water for twenty-four hours to remove the superfluous chromic acid. The yolk-membrane may be very readily removed from the hardened germ without injuring the latter. The blastoderm is stained entire with weak ammoniacal carmine (length of staining twelve to twenty-four hours), then washed by twenty-four hours' immersion in distilled water and placed in absolute alcohol. It is ready for cutting in from one to two days. After lying for a few minutes in oil of cloves it is imbedded in a mixture of wax and oil. Sections are made by hand, using turpentine to moisten the object.

Preparing Embryos of Insects.†—In a paper on the embryonic development of the Bombycidæ, Dr. S. Selvatico describes the methods he has made use of both for the preparation of entire embryos and for sections. The species employed were *Bombyx mori*, *Attacus Mylitta*, and *Saturnia pyri*.

The eggs are first coagulated by plunging them in water at 75° C. With a pair of fine-pointed forceps a small piece is removed from the shell, in the case of *Bombyx*, without disturbing the underlying parts. With a little care this is easily done, because on the eggs becoming cold their contents are somewhat contracted and do not touch the shell. In the case of *Attacus* and *Saturnia* the eggs have a harder shell but are larger, and a razor was employed by the author.

They are then hardened by leaving them for twelve hours in a ·002 per cent. solution of chromic acid, and for twelve hours more in a ·005 solution. Then with a little care the shell can be easily

* Arch. Mikr. Anat., xx. (1881) pp. 181–2.
† Journ. de Microgr., vi. (1882) pp. 220–1.

removed by employing the forceps or cutting it round with a razor.

The entire contents having been removed the egg is freed from chromic acid by leaving it in 30 per cent. alcohol for a day, the alcohol being renewed until it is no longer coloured yellow.

For staining, the egg is placed in picrocarmine for twenty-four hours and washed in 30 per cent. alcohol to remove the picric acid. When it has been well washed it may be kept in 30 per cent. alcohol until sections are required.

Previous to cutting sections the egg should be placed in absolute alcohol for half an hour, and then for a few moments in essence of bergamot. Dry and imbed in a mixture of 4 parts of spermaceti and 1 of cacao butter, to which is added, according to the temperature, some drops of castor-oil. The knife should be moistened with olive-oil and each section washed with a mixture of 4 parts of oil of turpentine and 1 of creosote to dissolve the imbedding substance surrounding the section. Mount in Canada balsam.

To preserve the embryo entire, the shell is to be removed as above described, after coagulation. The egg is then placed in a drop of water on the stage, and with a low power the embryo is extracted from the vitellus. It is cleaned as much as possible, so that no portion of the vitellus adheres to it, and mounted in glycerinated gelatine, previously coloured with methyl-green. By this method the embryo takes from the gelatine an excess of colour, and is thus stained after the preparation is made. If it is coloured first and then placed in colourless gelatine it will always lose colour (sometimes completely) if the gelatine is only a little greater in volume than the embryo.

Collecting, Staining, and Photographing Bacteria.*—Dr. G. M. Sternberg in "a contribution to the study of the bacterial organisms commonly found upon exposed mucous surfaces and in the alimentary canal of healthy individuals" (which contains much interesting matter), states that he has found the following to be the most satisfactory method of collecting bacteria for examination with high powers and for photography.

The slightest possible smear of the material to be examined is allowed to dry upon a thin glass cover, and to secure a sufficiently uniform layer, it is usually best to spread it while moist with the end of a glass slide. Material is obtained from the mouth by scraping the surface of the tongue, or of the teeth, with a clean instrument; from the female vagina by a speculum or digital examination; and from the male urethra, by applying a thin glass cover directly to the moist mucous membrane at the extremity of the canal.

A five-cent bottle of aniline violet ink furnishes an ample supply of staining fluid of the best quality. Two or three drops of this placed upon the thin cover will very quickly—one to three minutes—give the bacterial organisms attached to its surface a deep violet colour. The cover is then to be washed by a gentle stream of pure water, and is ready for immediate examination, or may be mounted

* Stud. from the Biol. Lab. Johns Hopkins Univ., ii. (1882) pp. 157–81 (19 photomicrographs).

for permanent preservation over a shallow cell containing a solution of potassium acetate (Koch's method), carbolic acid water (2–5 per cent.), camphor water, or simply distilled water.

To make satisfactory photographs of the smallest bacteria, it is necessary to use a staining fluid which will give a stronger photographic contrast, as the violet is transparent for the actinic rays. For this purpose aniline brown (recommended by Koch) may be employed, or iodine solution (iodine 2–5 grains, potassium iodide q. s. to dissolve, distilled water 100 grains).

A recent writer (Soubbotine *) advises the use of osmic acid as a fixing solution to be used in advance of staining. This is doubtless desirable when specimens of blood or thin sections of tissue containing bacteria are to be examined, as the normal histological elements are better shown, but the method possesses no special advantages so far as the demonstration of vegetable organisms is concerned. It must be remembered that aniline solutions often contain a granular precipitate which might be mistaken by a novice for deeply stained micrococci.

Ehrlich's Method of Exhibiting the Bacteria of Tuberculosis.†—Dr. Ehrlich, Prof. Koch's assistant, has lately explained ‡ a new method of preparing tuberculous bacteria, which is a great improvement on the original process of Koch. It renders the demonstration much easier, and its results are so certain, that it may be applied to establish the diagnosis of the disease in doubtful cases. The preparations made according to the method recommended by Koch in his first paper (i. e. double staining by alkaline methylene-blue and vesuvin §) have left doubts in the minds of some observers, which they could not have had if they had seen the preparations obtained by Ehrlich's process which Koch himself has now adopted in preference to any other.

Tuberculous bacteria as well as all the micro-organisms, bacteria, or micrococci, have a great affinity for aniline colours, and are strongly stained by them. Koch's researches have shown that the bacteria of tuberculosis have special and characteristic properties, and that their cellular membrane is very easily penetrated by alkalies. It is upon this experimental fact that Koch based his ingenious method, which consists essentially in impregnation by an aniline colour, rendered alkaline by the addition of a small quantity of caustic potash.

But this alkali exercises a modifying action on the different histological elements and on the bacteria themselves. Under its influence the albuminoid corpuscles swell to excess, and the coagulated layers of morbid matter are easily detached from the cover-glasses. Ehrlich, therefore, sought for another base, acting in a less powerful manner, and found it in *phenylamine* or *aniline*. Other alkaloids, perhaps even vegetable alkaloids, which can be transformed into colouring matters by means of various reagents, might be equally useful.

* Arch. de Phys., viii. p. 479.
† Bull. Soc. Belg. Micr., vii. (1882) pp. cxvii.–cxxii.
‡ See Berl. Klin. Wochenschrift, 6th May, 1882.
§ Cf. this Journal, *ante*, pp. 385–8.

The following is Dr. Ehrlich's method of procedure, which does not present any technical difficulty, and does not require more than an hour to make a dozen preparations. By means of a dissecting needle a particle of expectorated matter, about the size of a pin's head, is taken up and spread between two cover-glasses, * in two exceedingly thin layers on each. The cover-glasses are then separated by sliding one on the other, and left to dry protected from the dust. After a few minutes they are dry, and the fixing of the albuminoids and mucin is proceeded with. For this they can be warmed for an hour at 100° or 120° C., or which is simpler, rapidly passed four or five times through the flame of a spirit-lamp. To colour the preparations a saturated solution of phenylamine is to be made in distilled water,† by shaking with the water the excess of aniline which floats on it, and carefully filtering the whole. To the transparent liquid thus obtained add, drop by drop, a saturated alcoholic solution of *fuchsine* or *methyl-violet* until a slight opalescence is produced. The preparation should not be immersed in the colouring bath, but be placed in such a manner as to float on it, and to have the surface which is covered with the tuberculous matter in contact with the liquid. After a quarter to half an hour the staining is complete.

If examined in this condition it is seen that the preparation is of such an intense colour that it is impossible to distinguish its elements, and Ehrlich happily thought of trying to decolorize it by means of a strong acid; colourless salts of aniline are then formed, which are very soluble in water and disappear by washing with distilled water. The bacteria, not being penetrated by the acids, preserve their colour. In order to secure that they alone shall be coloured, therefore, it is only necessary to immerse the cover-glasses in nitric acid diluted with twice its volume of water. Nitrous vapours are at once disengaged, and the preparation becomes absolutely colourless in a few seconds. Under the Microscope the bacteria are seen to be very clearly coloured red or violet; but by reason of their extreme delicacy they often escape the eye and require the most accurate focussing. It is therefore better to study them in preparations which have been slightly coloured blue or green (when fuchsine has been used for the first bath), or yellow (when methyl-violet has been used). They are afterwards mounted in Canada balsam in the usual way.

The advantages of Ehrlich's method are summed up by Dr. E. Van Ermengem as follows:—1st. The aniline alters the form of the histological elements much less than Koch's solution of potash. 2nd. The process is much quicker, and does not occupy more than an hour. 3rd. Its principal advantage is to produce a more intense staining of the bacteria, so that they appear larger, and can be recognized with a lower power, even with 250 diameters.

A question of the highest interest from a medical point of view

* Ehrlich chooses cover-glasses whose thickness is appropriate to the objectives to be employed; those from 0·10 to 0·12 mm. he considers the most suitable.

† The water dissolves about one part in thirty-one at the ordinary temperature, 12° C.

has been raised by Ehrlich with reference to his method. The properties which the membranous envelope of the bacteria of tuberculosis seems to possess, prove that the sole disinfectants or antiseptics which can be used to combat this disease, by acting on the bacteria, *should be alkalies and not acids*, which have hitherto been employed for this purpose.

At the May meeting of the "Société Belge de Microscopie," Dr. Van Ermengem exhibited a series of preparations of tuberculous bacteria obtained from expectorated matter from five patients suffering from pulmonary phthisis of the second and third degree. In each of these cases a few particles of the sputa sufficed to give at least one preparation in which the characteristic bacilli were found.

The first series of preparations were made according to Koch's method. The bacteria were few and difficult to find. They were feebly coloured (a pale blue), and were very small. To show them clearly a very bright light, obtained by means of an immersion condenser, and the use of a good immersion objective were necessary (1080 diameters).

The second series were partly made by Ehrlich's process. The bacteria were coloured a bright red by fuchsine, the rest of the preparation being completely colourless. In one of the preparations the typical bacteria were very numerous, in groups numbering from four to eight within large cells, or disseminated in pairs here and there, and it was not difficult to recognize the spores: often also they were placed end to end in pairs. The organisms corresponded well with the description given by Koch, and were perfectly recognizable without a condenser and without a high power (750 to 800 diameters.)

A few good preparations were also shown in which the ground had been coloured blue. The bacteria were more easily found than in the others, and stood out clearly by their fine red colour from the rest of the preparation (450 diameters).

Specimens of these bacteria prepared by Koch (on his old method) were exhibited by Mr. Watson Cheyne and Mr. E. M. Nelson at the two soirées of the Royal Society on the 10th May and 21st June, and also at that of the College of Physicians, and attracted considerable attention, not only from the interest which attached to Koch's discovery, but also for the excellent way in which they were shown.

Preserving Infusoria and Amœbæ.*—E. Korschelt refers to the method described by M. Certes for colouring and preserving Infusoria,† in regard to which O. Bütschli in his abstract of the paper expressed a hope that it would be possible to find a more suitable preserving method as he could not place reliance on preservation in glycerine. The author considers that the following method (which he devised without knowing that of M. Certes) will enable preparations to be made which leave nothing to be desired in regard to durability.

The water in which the Infusoria are placed upon the slide must

* Zool. Anzeig., v. (1882) pp. 217–9.
† See this Journal, ii. (1879) p. 331.

be as small in quantity as possible in order to prevent the animals swimming away during the process, which is entirely carried on under the cover-glass. After the cover-glass has been put on a drop of a 1 per cent. solution of osmic acid is added and sucked through from the other side, then water, 70 per cent. and 90 per cent. alcohol, and finally water again. For the colouring of the now sufficiently hardened and fixed animals, Weigert's picrocarmine process * is recommended. This should act an hour and a half to two hours, the preparation being placed in a moist chamber in order to prevent drying. After removal of the colour 70 per cent., 90 per cent., and absolute alcohol, oil of cloves, and finally Canada balsam are added.

This process, which in reality takes only a short time, gives very excellent results for many Infusoria. In the case of others, however, the use of osmic acid is not so good, and with *Amœbœ* it is entirely without result. For these organisms, therefore, a 2 per cent. solution of chromic acid is preferable, which must act for two to three minutes in order to harden them sufficiently, otherwise in washing they readily swell up and burst. The remaining process is the same as the previous one.

The duration of the action of the agents varies of course for different animals, depending upon their size and fineness—the most different Infusoria and Flagellata have been preserved in this way without manifesting the slightest shrinking. The cilia and vacuoles are quite life-like, and show the nucleus and nucleoli with an intense red colour. By far the best result, however, of the method is, the author considers, in its use for *Amœbœ*, the preserving of which had hitherto not succeeded. They are fixed in the position in which they are at the moment of the chromic acid being added. Even in the fine pseudopodia the vacuoles are easily to be recognized. The nuclei are also distinctly coloured.

In a postscript the author adds that Dr. A. Gruber, of the Freiburg Zoological Institute, who had previously found the process very useful for Rhizopoda and allied organisms, has since tried it on Heliozoa and found it to succeed excellently.

Preserving Protozoa.†—Referring to the preceding paper, B. Landsberg considers that it is a disadvantage that all the operations have to be performed under the cover-glass. It is scarcely possible, therefore, to prepare clean slides, as foreign bodies once under the cover-glass cannot be removed. It is also to be doubted whether the osmic acid can act with the necessary suddenness and in sufficient concentration, and finally there is the danger of the object swimming away.

He therefore proposes a method which obviates all these inconveniences, and which even a beginner can soon learn.

A small quantity of water being placed in a watch-glass or on a slide (without a cover-glass), is observed under the Microscope, and when an object is seen which it is desired to mount it is sucked up by a fine pointed capillary tube, taking care to have a little

* Arch. f. path. Anat. u. Physiol. (Virchow) lxxxiv.

† Zool. Anzeig., v. (1882) pp. 336–7.

water in the tube at first, so that the animal may not be destroyed by too strong a rush of water. The water is then emptied out of the tube into a drop of 1 per cent. osmic acid on another slide, and the acid allowed to act for about ten minutes as a maximum. The animal is then stained with Beale's carmine, washed with water, and after gradually hardening in alcohol transferred to oil of cloves.

Another process is to be recommended for small quick-swimming Protozoa. After it has been ascertained that the water in the watch-glass contains many Protozoa a sufficient quantity of osmic acid is poured in, and the subsequent processes of staining, washing, and transferring to alcohol and oil of cloves are all performed in the watch-glass. The animals are so fixed in the sediment that it is rarely any are lost in sucking off the fluid. Then a drop of the oil of cloves is taken up under the Microscope in a wider tube, and the organisms brought away isolated by the capillary tube and put at once into Canada balsam.

Although Canada balsam preparations have the advantage of greater durability, yet glycerine is to be preferred for many Protozoa. In particular, *Actinosphærium Eichhornii* is much more beautiful in glycerine than in Canada balsam. The frothy condition of the ectosarc is shown most clearly, and the contractile vacuoles remain, as in the living state, prominent at the surface of the animal.

Staining the Nucleus of Living Infusoria.—We are sorry that by the interpolation of the word "erroneously" at p. 281 it was made to appear that M. A. Certes was not justified in claiming as a "new fact" the staining of the nucleus of living Infusoria. The author of the interpolation, to whom we have referred on the subject, informs us that the fact of the note dealing with the *living* animals had momentarily escaped his attention.

Double Staining with Carmine and Anilin Green.*—Mr. T. W. Taylor obtains very beautiful results from the following method of using preparations of carmine and anilin green † together.

The section is immersed from five to ten minutes in the green, and then passed at once into the carmine, in which it remains from one to three minutes, the process being carefully watched in order that the carmine may not stain too deeply. It is then thoroughly washed in absolute alcohol, passed through oil of cloves, and then mounted in solution of balsam in benzole. The use of the benzole-balsam is important, as it has a decided action in fixing the stain, due to the presence of benzole. Two or three drops of each liquid suffice, and the whole operation is performed upon a glass slide, or in a watch-glass.

The woody parts of the section take a rich carmine, shading into orange, while the pith and light cellular tissue are stained a bright

* Amer. Mon. Micr. Journ., iii. (1882) pp. 92–3.

† Carmine stain: carmine 15 gr., ammonia 15 gr., distilled water 2 oz.; dissolve carmine in ammonia over the flame of a spirit-lamp, add the distilled water and filter. Green stain: anilin green 5 gr., absolute alcohol 1 oz.

orange-yellow. In a section (transverse) of the leaf-stem of the sago-palm, the outer cells, which are smaller and more compact than the more central ones, were dyed a rich orange-yellow, and their nuclei a bright carmine. The curious large ducts in the central portion of the stem, which, as a system, form in a transverse section a figure like the Greek capital omega, take a pleasing variety of shades, the cells around the edges being a bright orange, the central cells shading down to deep carmine. These sections of the midrib of the sago-palm are beautiful objects stained or unstained, and one of the best examples of curious cell arrangements to be found anywhere.

The action of the dyes made from the above formula is quick and certain, and the effects very satisfactory.

Cutting Sections of Coal.*—Some discussion has taken place as to the feasibility of the method mentioned in the 'Micrographic Dictionary,' of macerating the coal in a solution of carbonate of potash, several authors finding that the coal still remained quite hard and impossible to cut. C. L. Lord finds the following method to be easy and successful when tried on the particular kind of coal mentioned by Huxley as containing macrospores and microspores in such abundance, viz. the Better-bed coal of Bradford and district. Grind a chip of coal to a smooth surface on an ordinary school-slate. Then cement it to a glass slide, either with shellac or Canada balsam. If balsam is used, it must be evaporated until it is of such hardness that a dent can only just be made in it by pressure with the thumb-nail, then remelt it and fix the smooth surface of the coal to the slide. The coal may then be ground on the slate to such a thinness as to show the spores. The coal-matrix containing the spores cannot be ground sufficiently thin to be transparent, and if it could be so ground, it is doubtful whether there would be any organic structure perceivable.

J. Walker selects from soft Iowa coal, some hard heads, so called (that is, hard lumps of coal in various stages of transition from good coal to charcoal), and well-preserved wood mixed with sulphide of iron. Breaking up these lumps and cutting out with a chisel the wood from the coal, which is the same as the coal without the bitumen, and breaking this in the proper direction, sections can be got both ways of the tissue, and when ground down thin make a good transparent object, or opaque with the condenser, when the sulphide of iron glistens like gold-dust among the woody tissue.

W. H. Harris has tried repeatedly to get a good slide of ordinary coal, and the outcome is one section only that shows any structure, and this was cut from ordinary marketable coal from Illinois, U.S.A. A piece of the coal was cut about a quarter of an inch in thickness with a fret saw, placed in pure turpentine for some considerable time, and then in dilute Canada balsam, until it was saturated. The turpentine was allowed to evaporate, and by a gentle application of heat the balsam the section had absorbed was gradually hardened. One side was then ground flat, polished and cemented to the slide;

* Sci.-Gossip, 1882, pp. 89, 136–7.

when completed the other side was a simple repetition of careful grinding on a water-of-Ayr stone, just as an ordinary rock section would be treated, only with more care when the critical point was approached.

Finally, Dr. C. H. Griffith, one of the editors of the 'Micrographic Dictionary,' says he is "greatly amused at the discussion," and suspects the writers "have been experimenting with the refractory anthracite coal too common in our coal-scuttles; but this being nearly all mineral matter, of course, does not yield to the action of the potash. Neither would it show much if so cut. They remind me of a former sapient microscope pupil of mine, who took to himself much credit for soaking a nail from the 'Victory,' in the hope of making a section of it for the Microscope to show the structure. The coal for which this process is recommended, and which yields the best objects, is that which is more of a lignite character, and when so treated and digested with heat, is cut readily. To my own knowledge Professor Henfrey cut hundreds of sections in this manner."

Sections of Mica-schist.*—In a paper describing the methods he originally adopted for rock sections, Dr. H. C. Sorby says that it is possible to prepare thin sections of mica-schist perpendicular to the foliation, although it is so friable that at first sight it appears impossible. Having got a fairly thick portion and reduced it to about $\frac{1}{8}$ inch, it must be wetted well with turpentine so that it may penetrate into the pores of the rock, and then covered over with Canada balsam and kept hot inside the fender. The balsam penetrates into the loose material, and thus supplies artificially what nature has failed to supply in not having hardened it sufficiently by infiltered quartz. It is well to repeat the process after a little time.

By this means the weak points of the mica-schist and the planes of discontinuity are filled with hard Canada balsam so as to make it thoroughly hard throughout, and enable it to be rubbed down and the section left of the desired thickness.

Paper Cells.†—Mr. W. H. Walmsley, in an article (the third of a series) on Dry Mounting, considers that the remedy for the appearance of moisture in cells is to be found in "sacrificing artistic cells of wax, with their pretty coloured rings of varnish, and being content with those of humbler and far more useful qualities. Paper, from which such dissimilar articles are now manufactured as love-letters and car-wheels, is our friend in need in this emergency,—not sized, or glazed, or calendered, but soft, porous paper of various thicknesses to suit our needs; a thick blotting pad being exceedingly useful for cells containing objects sufficiently thick to require such a depth."

Wax Cells.‡—Mr. T. Whitelegge proposes "a very simple method of making wax cells. A piece of glass tubing is first drawn out to a point so as to form a pipette, and this is filled with melted

* North. Microscopist, ii. (1882) pp. 134–5. Cf. also Mr. Rutley's process, this Journal, iii. (1880) p. 849.

† 'The Microscope,' ii. (1882) pp. 1–8.

‡ North. Microscopist, ii. (1882) p. 194.

white wax. The slip upon which the cell is to be made is placed on the turntable, and while it is spinning, touched with the point of the wax pipette, previously heated so that the wax may flow out readily. A wax ring is thus made quite as easily as one of varnish, and if the ordinary pharmaceutical white wax be employed, it will adhere very tenaciously to the slide. It is obvious that many varieties of rings may be made by modifying the temperature of the wax or even by warming the slide, and as an operation of this kind generally requires some little practice in order to obtain the best results, a few failures at the outset should not discourage the operator from further attempts."

Miller's Caoutchouc Cement.—Mr. R. Miller, while not claiming to have discovered any new substance, has hit upon a new method of combination by which a material is obtained easy and quick to work and reliable in its results, and available both for making and sealing cells. It has stood a test of eighteen months.

The following are his directions for using it:—

To turn Cells.—Centre the glass slide on the turntable, and with a camel's-hair brush previously charged with sufficient cement, mark off the foundation of the cell in width and size required, the turntable being somewhat rapidly revolved; dip more cement and apply directly before the first layer can set, and so on, always touching the top of the stream only, until the cell be raised to the height desired, then lay the slide aside in a level position to dry. Slight cells dry in a few hours, deep cells, say $\frac{1}{8}$ of an inch, in two or three days. One hundred perfect cells may be turned in an hour by a beginner, and nearly twice that number by an adept. (Keep the brush clean and the bottle tightly corked.)

To mount in Glycerine, Oil, Canada Balsam, or other Fluids.—Take a cell perfectly dry, apply or turn a sufficient layer of the cement round the top of the cell, slightly overfill the cell with glycerine, and put in the prepared object, place on the glass cover (previously tested to fit), press down the centre and edges of the cover until it is firmly in position, and with a damp brush gently remove the expelled glycerine; test again by slight pressure that the cover is on the cement, and lay aside to set. A few hours afterwards the slide may be immersed in a basin of water and thoroughly cleansed with a camel's-hair brush, wash again if necessary, and when thoroughly freed from all traces of glycerine and quite dry, turn a layer of the cement over the cell embracing the rim of the glass cover, and finish to taste. The slide will then be found to be durably sealed and the fluid permanently confined.

These directions apply to mounting objects in oil or fluid Canada balsam, except the use of water to clean them; the superfluous oil or balsam must be removed by a brush dipped in benzole, the brush being continually wiped between a cloth. Do not use balsam diluted with ether or chloroform.

Mounting in Phosphorus.—The following is the note which Dr. Morris has written out, as mentioned, *post*, p. 591. It must,

however, be borne in mind that the sole advantage of phosphorus is its high refractive index = 2·1. If it is diluted to 1·7, no benefit is derived from its use over bisulphide of carbon or other substances whose refractive index = 1·7, and they should therefore be used in preference. Dr. Morris's note, however, contains some useful hints.

"Having seen several specimens of diatoms mounted in phosphorus and bisulphide of carbon, I am under the impression that the solution is too strong for the purpose required, and as I have mounted some hundreds of slides in the strong and weak solutions, I have come to the conclusion that the weak solution is the best and safest for mounting minute objects, such as the Diatomaceæ.

"The solution I use is made as follows :—Take one ounce of carbon bisulphide and put it into a wide-mouthed stoppered bottle, and add about two or three drachms of phosphorus piece by piece, taking the precaution to previously absorb all the moisture from its surface by placing it on blotting-paper for a second or two. When all is dissolved, filter through white filtering-paper and a glass funnel into another bottle (narrow-mouth stoppered), wash the filter with a little carbon bisulphide, and when filtered place the filter in a basin of water until there is time to burn it in the fire.

"Having made and filtered the solution, take a small piece of white blotting-paper about an inch square, and with a glass rod put a drop of the solution on the paper and watch the effect. If it flares up with a yellow flame it is too strong, and requires more carbon bisulphide added to it, but if it only smokes and carbonizes the paper the solution is of the right strength. See that the stopper is well fixed in the bottle, and put it away for a day or two. If any sediment has formed in the meantime, filter once more, using the same precautions with the filter as before.

"If the solution is made according to the above directions, it will be always ready for use and keep for months.

"To make cement for the cover-glass, take of good isinglass one ounce, put it into a saucer, add a few drops of water from time to time until the isinglass is moistened but not pappy. Put about two ounces of glacial acetic acid into a porcelain capsule, place it over a spirit-lamp, and bring the acetic acid to boiling-point. Add the isinglass by degrees until the whole is dissolved, keeping the mixture constantly stirred. Boil until a spot placed upon a slip of glass becomes solidified when cold. When sufficiently boiled, put it away in a wide-mouthed bottle, using a cork for a stopper. A small quantity for constant use may be kept in a two-drachm bottle. This must always be warmed in hot water before applying it.

"The diatoms being fixed on the cover, see that the following articles are at hand :—A small bottle of carbon bisulphide, a glass pipette four inches in length terminating in a fine point, a few pieces of blotting-paper one inch by half an inch, small camel-hair brush, mounted needles, a small basin, and a turntable.

"First gently warm the slide, centre it on the turntable, warm the cover-glass and place it on the slide, wash the pipette with the carbon bisulphide, then with the pipette take up a small quantity of

the solution of phosphorus and allow it to run under the cover just sufficient to float it. See that there are no air-cells, if so, gently move the cover backwards and forwards to the mounted needles, when all the air-cells will disappear. Take the small brush, load it with the warmed cement, and touch the edge of the cover-glass at right angles in four places, then gently revolve the turntable, keeping the brush close to the edge of the cover until the cement ring is complete, then absorb the remainder of the phosphorus solution on the slide with the strips of blotting-paper, putting the paper into the basin of water so that it can do no harm. As long as the blotting-paper saturated with a solution of phosphorus is wet, no combustion will ensue. Hence the necessity of seeing that all which has touched the solution of phosphorus has either undergone combustion or been placed in the fire before leaving off work.

"The mounted slide may be again touched with the cement, when it can be put away until the following day. A ring of solution of sealing-wax or shellac may then be used to finish it off. If by accident more of the cement has got on the slide than is required, when the ring of sealing-wax is hard, the cement can be washed off with a small brush dipped in water and applied gently. When dry it can then be finished off as the mounter may fancy.

"Always wash the pipette in the carbon bisulphide before and after using the solution of phosphorus. Latterly I have discarded the soft cell and always mount as described, because I found that the solution of phosphorus is very liable to form air-cells; or, in other words, there is a want of affinity between the glass and the medium, and if it is a valuable preparation it may be completely spoiled on account of the air-cells; whereas by doing away with the soft cell and mounting as I have described, the air-cells can always be got rid of before applying the ring of cement.

"Diatoms are easily resolved in this medium, which in a dry or balsam mount are unresolvable."

Vacuum-bubbles in Canada Balsam.*—Mr. W. M. Bale says, "One of the first difficulties which a novice in mounting meets with arises from the formation of air-bubbles in Canada balsam, but experience shows him that if the balsam be used in not too thick a state, any bubbles that may form in it will, unless they are excessively large, gradually disappear in the course of a few days at most, and henceforth air-bubbles in the balsam cease to be a source of trouble.

It is otherwise, however, with vacuum-bubbles, which are apt to appear in any closed cavities of an object at the moment of applying the balsam, even though every cell may have previously been perfectly filled with turpentine or carbolic acid. The cause appears to lie in the different densities of the fluid and the balsam, the former finding its way out of the cell to mix with the balsam, while the latter, owing to its greater density, is unable to enter the cell and supply its place. A vacuum is therefore left, which has all the appearance of an air-bubble, and which may either take a globular form or expand till it

* Journ. Micr. Soc. Victoria, i. (1882) pp. 103-4.

completely fills the cell. In the former case it is evident that the balsam is finding its way into the cell, though slowly, and if it is thin enough to retain its soft condition for a few days, the bubbles will probably disappear; but when they completely fill the cell it is a sign that the balsam cannot find entrance, and the object can then only be cleared by again soaking it in the fluid solvent. Among the objects most liable to this inconvenience may be mentioned sections of some wood, also such Bryozoa as some of the common *Catenicellæ*, the avicularian processes of which usually contain perfectly closed-in chambers. In the closed gonothecæ of some of the most delicate hydroids the same cause is followed by different results—the escape of the fluid and the inability of the balsam to enter, causing the collapse of the thin chitinous investment, instead of the formation of a vacuum-bubble, as is the case where the wall of the closed cavity is strong enough to resist the pressure of the balsam. Precisely the same phenomenon is observed when delicate vegetable tissues are placed in glycerine, and the means used to prevent it, viz. thickening the medium very gradually, suggested to me the idea of applying the same principle to balsam mounts.

An easy method of doing this is to place the object in turpentine on the slide under a large cover-glass, and with a glass-rod, deposit round the margin an embankment of soft balsam, then lay the slide aside till the balsam and turpentine are thoroughly mixed, which will be a slow and gradual process. It is not advisable to use carbolic acid for this work, at least if there be any considerable depth between the cover and the slide, as the mixture of acid and balsam assumes a rather deep colour. A slight modification of this plan may be used with advantage to prevent delay in the drying of the slide, as follows:—Place the object (saturated with carbolic acid) in the middle of the slide, and make a little embankment of balsam at some distance all round it, then fill the space within the balsam with a pool of the acid, and place the slide under the cover till the acid and the balsam are sufficiently mixed (ten minutes or a quarter of an hour), then drop fresh balsam on the object and cover as usual. Turpentine is not suitable for this purpose, as it runs all over the slide."

Mounting Moist Objects in Balsam.*—Dr. Johnson (of Victoria) some years ago recommended as a means to mount Sertularians, Bryozoa, &c., that the objects should be boiled in water till all the air is removed, then drained, placed for a few hours in carbolic acid, and thence transferred to the slide and mounted in balsam. It will be found, however, writes Mr. W. M. Bale, "that the water contained in the interior of the specimens being taken up by the acid will, unless a large quantity of the latter be employed, or the objects be placed in two successive baths of it, be sufficient to cause a cloudiness in the balsam. Moreover, it is frequently undesirable to lose time by putting the object aside till the water and acid have completely mixed; and to remedy these inconveniences, the object, after removal from the water, should be placed in methylated spirit, which will

* Journ. Micr. Soc. Victoria, i. (1882) pp. 104–5.

take the place of the water in a very few minutes, thence it may be transferred to carbolic acid and boiled in it for fifteen or twenty seconds, when the object will be ready for mounting at once. I use this method for all moist specimens, and find it of great advantage in enabling me to mount them without delay, besides which, the quantity of acid used or spoiled is comparatively small, its place being partially filled by the inexpensive methylated spirit."

Moisture in Dry Mounts.*—Mr. W. M. Bale adopts the following very simple plan of mounting objects to allow of the circulation of air through the cell. Take an ebonite cell, and if necessary trim the edge neatly with a file, then with a file or knife cut two opposite broad, shallow notches on that side of the cell which is to be underneath; then cement the cell to the slide, taking care not to allow the cement to fill the notches, which, being shallow, are quite unnoticed unless looked for. The object may be placed in the cell, and the cover cemented on at leisure. If a bright edge be required to the cell, it is only necessary to paint it with a thin solution of balsam or dammar, and no varnish ring on the cell is requisite (unless some other colour than black be desired), as the ebonite cell supplies in itself a sufficiently neat finish. Those who are in the habit of using the excellent slides made by glueing perforated wooden slips to strips of card, can easily provide for the circulation of air by making one or two small slits in the card bottom of the cell.

To obtain the freest circulation of air through the cells it will be advisible to leave the slides in an open rack box till the cement is hardened, rather than to close them up at once in a cabinet.

Dammar Varnish.†—This being, according to W. Pfitzner, preferable to Canada balsam, he prepares the solution in the following way:—Gum dammar, benzine, and turpentine, are mixed in equal parts, and put in a warm place. As soon as complete solution has taken place, the clear liquid is poured off, and allowed to evaporate until of the required consistency. Dr. M. Flesch ‡ adds that in Würzburg, dammar varnish, as used by painters, is generally employed.

Cleaning Used Slides and Covers. § — Mr. F. Barnard recommends the warming of the slide over a spirit-lamp and removing the cover, which is at once to be dropped into a bottle containing methylated spirit of wine, to which has been added 25 per cent. of liquor potassæ. Then scrape off as much balsam as possible with an old knife, and with a rag wetted with the above mixture clean the slide. Afterwards, a second rag wetted with the same liquid is used if necessary; and *while wet*, the slides are dropped into a basin of water. It will then only be necessary to thoroughly wipe them with a clean cloth. Breathing on them will show at once whether they are clean or not.

* Journ. Micr. Soc. Victoria, i. (1882) pp. 101–3.
† Morphol. Jahrb., vi. (1880) p. 469.
‡ Zool. Jahresber. Neapel for 1880, p. 51.
§ Journ. Micr. Soc. Victoria, i. (1882) pp. 106–7.

While the slides are cleaning, the cover-glasses should be soaking in spirit and potash. They may now be removed one by one, and wiped on a rag. If necessary, they can be so treated a second time; but in either case they are to be dropped while wet into clean water. In removing the covers it will be found that the spirit and potash has decomposed the balsam and any gold-size, black varnish, &c., upon them, and the dropping them while wet into the water prevents the adherence of any particles by the decomposition caused by it.

Mr. Barnard has tried benzine, turpentine, and many other things, but nothing seems so expeditious and cleanly as the mixture recommended, as it frees the slide from grease, which has to be done after using benzine or turpentine. There is a risk in leaving the covers in the bottle of spirit and potash too long, for fear of an injurious effect of the potash on the glass; but this has not yet happened, though they have been left uncleaned for a long time after being removed from the slides.

Resolution of Amphipleura pellucida. — Mr. E. M. Nelson informs us that since the date of the December conversazione of the Society he has found that the exhibit he then made of *longitudinal* lines on *Amphipleura pellucida* (dry on cover-glass) was an error—the lines then shown were due to diffraction. He has since observed true longitudinal lines on this diatom by a more careful adjustment of the vertical illuminator, and has assured himself that they are finer than the 10th band of Nobert's latest 20-band plate, i. e. finer than 112,595 to the inch. The objective was Powell and Lealand's $\frac{1}{12}$ homog. imm. of 1·43 N.A.

Repeated countings of the *transverse* lines on the particular frustule examined show them to be at the rate of 96 in the ·001 inch, and therefore capable of resolution by any immersion objective (of sufficient power) whose effective aperture exceeds 1·0 N.A., and conversely incapable of resolution by any dry lens.

Microscopic Examination of Wheat-flour.*—C. Steenbuch recommends the following mode of preparing meal for microscopic examination and determination of the starch-grains, by which the elements of the tissue can be easily isolated. The process depends on the well-known fact that a solution of diastase transforms starch-paste into dextrin and maltose. In order to obtain a solution of diastase, 20 g. of ground meal are placed for an hour in 200 g. cold water and repeatedly shaken, and then filtered through a double filter. 10 g. of the specimen of meal to be examined are then thoroughly mixed with 30–40 g. of cold water, the mixture placed in a beaker, and stirred up with about 150 g. of boiling distilled water. At a temperature of 75°–80° C. the formation of paste begins. The temperature is now allowed to fall to 55°–60° C., and 30 c.cm. of the clear filtered extract of malt added. The mixture is then stirred up, and the temperature kept at 55°–60° in a water-bath for 10 minutes.

* Ber. deutsch. chem. Ges., xiv. (1881). See Bot. Centralbl., x. (1882) p. 140.

Destruction of Microscopical Organisms in Potable Water.* —Langfeldt, in seeking for a substance which would kill the living organisms without injuring the water for drinking purposes, found that citric acid ($\frac{1}{2}$ gram per litre of the water) killed all except *Cyclops* and those with thick epidermis, within two minutes.

Public Lectures in Microscopy.†—In October last the French Minister of Agriculture and Commerce instituted a gratuitous course of instruction in micrography at the "Ecole Supérieure de Pharmacie" at Paris, intended for theoretical and practical instruction in the functions of microscopical experts.

Andrews, R. T.—Mounting Entomostraca.
[Inquiry for directions.]
Sci.-Gossip, 1882, pp. 160.

B., T. R.—Mounting *Volvox globator.*
[Slides mounted in 1878 are as good to-day as when fresh, except a *very slight* loss of colour. They were mounted alive in glycerine jelly as *cool* as possible. *Volvox* mounted in Canada balsam have not changed colour at all.]
North. Microscopist, II. (1882) p. 162.

Bale, W. M.—On Mounting Diatoms in symmetrical groups. [*Post.*]
Journ. Micr. Soc. Victoria, I. (1882) pp. 97–9.

„ „ Notes on Dry and Balsam Mounting. [*Supra*, pp. 581–3.]
Journ. Micr. Soc. Victoria, I. (1882) pp. 101–5.

Barker, H.—Photo-micrography.
[General directions for amateur beginners with dry plates.]
Journ. Post. Micr. Soc., I. (1882) pp. 75–80 (1 fig.).

Barnard, F.—On Cleaning used Slides and Covers. [*Supra*, p. 583.]
Journ. Micr. Soc. Victoria, I. (1882) pp. 106–7.

Birge, E. A.—On a Convenient Method of Imbedding. [*Ante*, p. 428.]
The Microscope, II. (1882) pp. 55–7, from *Amer. Mon. Micr. Journ.*

Boecker, E.—Ein neues Mikrotom mit automatischer Messerführung (A new microtome with automatic knife-carrier). [*Post.*]
Zeitschr. f. Instrumentenk., II. (1882) pp. 209–12 (4 figs.).

Bourne, A. G.—On certain Methods of Cutting and Mounting Microscopical Sections. [*Supra*, p. 567.]
Quart. Journ. Micr. Sci., XXII. (1882) pp. 334–7.

Brittain, T.—Micro-fungi: when and where to find them.
12mo, Manchester, 1882, 92 pp.

„ „ Microscopical Study.
[Brief general remarks.]
Rep. & Proc. Manchester Sci. Stud. Assn. for 1881, p. 4.

Brooks, W. K.—Handbook of Invertebrate Zoology for Laboratories and Seaside work.
[Containing directions for studying the general anatomy, the microscopical structure, and the development of selected types of animal life, &c.]
8vo, Boston, 1882, pp. viii. & 392 (202 figs.).

C., O.—On *Amphipleura pellucida.*
[Discursive—ending with an anecdote of an American microscopist who lived before the time of immersion objectives, and was a determined seeker after the resolution of this diatom, destroying his practice and reducing himself to poverty. "Weaker and weaker he grew in his

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* Chem. Centr., 1881, pp. 74–5; cf. Journ. Chem. Soc. Abstracts, xl. (1881) p. 1179.

† Rev. Mycologique, iv. (1882) p. 199.

wild chase after the phantom lines till death overtook him one night as he sat in his barren room surrounded by glittering brass tubes and flashing accessories, and his last breath was spent in a feeble attempt to whisper faintly 'wider-angle.'"]

Amer. Mon. Micr. Journ., III. (1882) p. 99-100.

Carbutt, J.—Photo-micrography.

Report of an address to the Camden Microscopical Society—*post*.]

The Microscope, II. (1882) pp. 43-4.

Cole's (A. C.) 24 sections of starch-bearing vegetables and starch-granules.

[Description of some of the slides.]

North. Microscopist, II. (1882) p. 195.

Coombes, C. P.—Cutting Sections of Soft Tissue.

[Description of Coppinger's and Dr. Rutherford's Microtomes and the plans of Dr. L. Clarke and of Dr. Klein (or German histologists) for cutting sections without apparatus.]

Journ. Post. Micr. Soc., I. (1882) pp. 61-3.

Dippel, L.—[Remarks on the paper of J. W. Stephenson, *ante*, p. 163.]

Bot. Centralbl., XI. (1882) pp. 105-6.

Eger, L., and M. Lessona.—Il raccoglitore naturalista, guida pratica per raccogliere, preparare, conservare i corpi organici ed inorganici. 2nd ed. (The Collecting Naturalist, practical guide for collecting, preparing, and preserving organic and inorganic bodies.) 8vo, Torino, 1882, 123 pp.

Elcock's Type-slides of Foraminifera.

[Description of the slides, which contain 50 species arranged in squares with the name of each photographed in readable type.]

Journ. Post. Micr. Soc., I. (1882) p. 104.

Ermengem, E. Van.—Démonstration de préparations de bactéries de la tuberculose. (Exhibition of preparations of bacteria of tuberculosis.) [*Supra*, p. 574.]

Bull. Soc. Belg. de Micr., VII. (1882) pp. cxvii.-cxxii.

Fleming, J.—Mounting *Volvox* in Glycerine Jelly.

[Reply to T. R. B.—"I boiled the Volvox in the jelly on the slide, the cover-glass being held in position during the boiling process by a rather loose clip."]

North. Microscopist, II. (1882) p. 192.

Freeman, H. E.—Sphæraphides of Cactus.

[Directions for separating them—they show best with a little light from below or with spot-lens.]

Journ. Post. Micr. Soc., I. (1882) p. 94.

Griffith, C. H.—Cutting Sections of Coal. [*Supra*, p. 578.]

Sci.-Gossip, 1882, p. 137.

Harris, W. H.—Sections of Coal. [*Supra*, p. 577.]

Sci.-Gossip, 1882, p. 137.

Hitchcock, R.—Photographing with the Microscope.

[Detailed directions for photographing with the dry-plate process.]

Amer. Mon. Micr. Journ., III. (1882) pp. 88-92 (2 figs.).

" " Aperture and Resolution.

[Remarks as to alleged resolution of 152,000 lines to the inch (*ante*, p. 416) and as to the appearance of lines in an image being no evidence that the image is produced by lines, and that the presence of lines in a photograph does not prove that the object is a lined object.]

Amer. Mon. Micr. Journ., III. (1882) p. 96.

" " Pond Life.

[Recommendation of Balen's tubes.]

Amer. Mon. Micr. Journ., III. (1882) p. 116.
See also *Amer. Natural.*, XVI. (1882) p. 618.

Holmes, E.—On the Continuous Observation of Minute Animalcula. [*Post.*]

Sci.-Gossip, 1882, pp. 138, 160.

" " Observations on Living Organisms.

[Inquiry as to the means adopted by those who have been successful in the continuous observation under the Microscope of very small and active organisms.] *Sci.-Gossip*, 1882, p. 159.

Holmes, E.—Sections of Coal.
[Comment on the notes of Messrs. Lord, Walker, Harris, and Griffith, *supra* and *infra*.] *Sci.-Gossip*, 1882, pp. 159–60.

Jago, W.—Crystals, Nos. II. and III.
[Directions for preparing slides of Crystals, and for the Microscopical Examination of Crystals formed naturally.]
Knowledge, I. (1882) pp. 601–2 (4 figs.); II. (1882) pp. 20–1 (4 figs.).

Kain, C. H.—Glass Cells. [*Post*.]
Amer. Mon. Micr. Journ., III. (1882) p. 101.

Kitton, J.—Cutting Sections of Coal.
[Reply to C. H. Griffith, *supra*.] *Sci.-Gossip*, 1882, p. 160.

Landsberg, B.—Ueber Conservirung von Protozoen (On preserving Protozoa).
[*Supra*, p. 575.] *Zool. Anzeig.*, V. (1882) pp. 336–7.

Lessona, M.—See Eger, L.

Lord, C. L.—Cutting Sections of Coal. [*Supra*, p. 577.]
Sci.-Gossip, 1882, pp. 136–7.

Michael's (A. D.) Note on Polarized Light as an addition to Staining.
[*Ante*, p. 426.]
[Brief notice of it—the writer considers that "there is little doubt that sufficient use is not made of the polariscope in the examination of tissues."]
Journ. of Sci., IV. (1882) p. 374.

Moore, A. Y.—The differential Staining of nucleated Blood-corpuscles.
[*Post*.] *The Microscope*, II. (1882) pp. 73–6 (1 pl.) 91.
„ „ Resolution of *Amphipleura pellucida*.
[Correction as to his claim—not by "central sunlight," but with "the mirror central," it being the rays of greater obliquity than 1·00 N.A. that really do the work.]
The Microscope, II. (1882) p. 85.

Nördlinger, H.—Descriptions of Sections of 100 kinds of wood partly European. Vol. x. (Vols. i.–ix. 1852–80).
[Cf. *Bot. Ztg.*, XL. (1882) p. 287.] 16mo, Stuttgart, 1882.

Nott, E. S.—[Finding of *Amphipleura pellucida* smaller than those of Möller in the ratio of 12 : 16, and the lines correspondingly finer.]
Amer. Mon. Micr. Journ., III. (1882) p. 99.

Ollard, J. A.—[Preparing] Stellate Hairs of *Deutzia*.
[Scrape the leaf carefully with a sharp knife and transfer to slide with camel-hair pencil.]
Sci.-Gossip, 1882, p. 138.

R.—The Microscope on the Druggist's Counter.
[Results of examination for adulterations.]
The Microscope, II. (1882) pp. 16–17.

Reynolds, R. N.—A Mount for Low Powers.
["Part section of a human heel cut from bottom upward"—with directions for mounting.]
The Microscope, II. (1882) p. 76.

Ross, W. S.—Aid of the Microscope in the Diagnosis of Diseases.
The Microscope, II. (1882) pp. 30–1
from *Western Medical Reporter*.

Roumeguère, C.—Leçons publiques de Microscopie. (Public Lectures on Microscopy.)
[Title more properly belongs to a foot-note on the same page, translated *supra*, p. 585. The above note refers to Dr. Van Heurck of Antwerp having set up Swan lamps in his laboratory, and to his lectures on Cryptogamic Botany.]
Rev. Mycologique, IV. (1882) p. 199.

Selvatico, S.—Sur le développement embryonnaire des Bombyciens. (On the embryonic development of the Bombycidæ.)
[Contains a description of the method employed for making preparations of embryos, *supra*, p. 570.]
Journ. de Microgr., VI. (1882) pp. 220–1.

Sorby, H. C.—Preparation of transparent Sections of Rocks and Minerals (*concluded*). [*Supra*, p. 578.] *North. Microscopist*, II. (1882) pp. 133–40.

STEPHENSON'S (J. W.) Process of Mounting Objects in Phosphorus, &c. [*ante*, p. 163.]

[Brief notice of it—the writer considers that "the operation should on no account be attempted by any but those accustomed to the use of dangerous chemicals."]

Journ. of Sci., IV. (1882) p. 376.
See also *Amer. Mon. Micr. Journ.*, III. (1882) p. 116.

STERNBERG, G. M.—Photo-Micrographs.

[Principally comment upon C. H. Kain's paper, *ante* p. 424, in regard to the brief time of exposure he found sufficient, with oil-light. Note by the Editor appended.]

Amer. Mon. Micr. Journ., III. (1882) p. 119.

" " A Contribution to the study of the Bacterial Organisms commonly found upon exposed mucous surfaces, and in the alimentary canal of healthy individuals.

[Contains Methods of Research, *supra*, p. 571.]

Stud. Biol. Lab. Johns Hopkins Univ., II. (1882) pp. 157–81 (3 photomicr.).

STOWELL, C. H.—The Student's Manual of Histology, for the use of Students, Practitioners, and Microscopists. 2nd ed.

8vo, Detroit, 1882, 290 pp. and 192 figs.

STURT, T. J.—What shall I do with the Microscope?

[Directions for mounting the "intestinal teeth of insects," *post.*]

Engl. Mech., XXXV. (1882) p. 282.

TAYLOR, T. W.—Double Staining with Carmine and Aniline Green.

[*Supra*, p. 576.]

Amer. Mon. Micr. Journ., III. (1882) pp. 92–3.

WADE-WILTON, E.—Letter as to his 'New Series of Living Specimens for the Microscope.' *Journ. Post. Micr. Soc.*, I. (1882) pp. 106–7.

WALKER, J.—Sections of Coal. [*Supra*, p. 577.]

Sci.-Gossip, 1882, p. 137.

WALMSLEY, W. H.—Some hints on the Preparation and Mounting of Microscopical Objects, III.

[Dry Mounting. (Paper Cells cf. *supra*, p. 578.)]

The Microscope, II. (1882) pp. 1–8.

WARREN, R. S.—The Preparation of Diatoms. [*Post.*]

Amer. Mon. Micr. Journ., III. (1882) pp. 111–5.

WEST, T.—An Hour at the Microscope.

[Six notes on diatoms, *Sphagnum*, sphæraphides, *Trichina*, proboscis of tortoise tick, and egg of louse of Vieillot's pheasant, with brief passing references in four cases as to preparing and mounting. Also note on irremovable black backgrounds, *supra*, p. 559.]

Journ. Post. Micr. Soc., I. (1882) pp. 90–4.

WHITELEGGE, T.—Wax Cells. [*Supra*, p. 578.]

North. Microscopist, II. (1882) p. 194.

WILSON, J.—Cutting Sections of Coal.

[Records his failure with the bi-carbonate of potash process.

Sci.-Gossip, 1882, p. 137.

WOOSTER, W. H.—Line and Pattern Mounting. [*Post.*]

Journ. Micr. Soc. Victoria, I. (1882) pp. 94–6.

PROCEEDINGS OF THE SOCIETY.

Meeting of 14th June, 1882, at King's College, Strand, W.C., The President (Professor P. Martin Duncan, F.R.S.) in the Chair.

The Minutes of the Meeting of 10th May last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Cole, A. C.—Studies in Microscopical Science, Vol. i. Nos. 1 and 2, and two preparations in illustration	*The Editor.*
Geological Magazine, Vols. i.–xviii. (1864–81)	*Mr. Crisp.*
Heurck, Dr. H. Van.—Synopsis des Diatomées de Belgique, Fasc. V. Crypto-Raphidées, 1e Partie, pls. 78–103	*The Author.*
Hitchcock, R.—Synopsis of the Fresh-water Rhizopods. (8vo, New York, 1881) 56 pp., with 4 pls. now added	*The Author.*
Jones, T. Rupert.—Catalogue of the Fossil Foraminifera in the Collection of the British Museum, pp. xxiv. and 100. (8vo, London, 1882)	*The Trustees.*
Micrographic Dictionary. 4th ed. Part 12	*Mr. Van Voorst.*

The President called special attention to the donation of a complete set of the 'Geological Magazine,' and Mr. Stewart referred to the 'Studies in Microscopical Science,' edited by Mr. A. C. Cole, the illustrations of which he considered were very good, and the letterpress appeared to be equally so. The novel feature was that a microscopical preparation accompanied each part.

Mr. Crisp exhibited a $\frac{1}{4}$-inch objective by Tolles, with a very tapering front, and stated that it was claimed on Mr. Tolles' behalf that he was the first to make such fronts about ten years ago.

Mr. Ingpen said that he had one of Andrew Ross's $\frac{1}{2}$-inch objectives with a triplet front, dated 1848, which was similarly tapered.

Mr. Beck said that he had made them in the same way for the last fifteen years.

The President, referring to J. L. de Lanessan's 'Traité de Zoologie—Protozoaires' (8vo, Paris, 1882, pp. vii. and 336, and 281 figs.), said that it treated of *Amœbæ* on a somewhat grand scale, particularly as regarded the larger kinds, and he would suggest to some of the Fellows that they should search for these species as being of great interest. He obtained one from the Hampstead ponds which he found full of minute refractile points.

Mr. Stewart said he had examined some large *Amœbæ*, a short time ago, which came from Mr. Ingpen's aquarium, and were crowded with refractile points. They were distinctly crystalline in character, and had a vesicular nucleus.

Mr. Hartog said that he used to find the nuclei in the large Amœbæ with a very distinct network, although one which he found had a hollow nucleus.

The President inquired if Mr. Hartog had ever been able to iodize Amœbæ?

Mr. Hartog said he had stained them with picro-carmine, but had not done so with iodine.

Dr. Ralph, the President of the Victoria (Australia) Microscopical Society, responding to a welcome from the President and the Meeting, said he should like to take the opportunity of bringing before the Fellows of the Society the examination of the leaves of various kinds of plants by means of the action of prussic acid and ammonia. The process was a very simple one, it being only necessary to place the section under the Microscope, and then introduce the compound. He had only had time as yet to examine a few kinds of leaves in this way, but the vine had hitherto given the most marked instances of the chemical action to which he referred. A longitudinal section as thin as possible being made of the leaf and placed under the Microscope, the fluid should be added, and would be found to penetrate the structure, chiefly acting on the ducts, which were within reach of the bark. In a few moments the most extraordinary colours made their appearance, such as claret, amber, port-wine colour, and others having all the appearance of a coloured injection of the tissue, only that in about a quarter of an hour it all disappeared. Other leaves which he had tried behaved much in the same way, though they did not all respond to the reagent in an equal degree. It was only in the brittle sappy stems that it was possible to get the best results. In consequence of these observations, he had been able to treat sections of the human subject with prussic acid with marked effects. Whenever he got in the plasma amorphous particles distinctly blue in colour, he also found the formation of amyloid bodies in the blood. These bodies were very well defined, and under favourable circumstances, in polarized light, the black cross could be seen. The production of amyloid forms by chemical means, not only under the action of hydrocyanic acid, but by chloral, formic acid, or solution of copper in ammonia, was a point of considerable interest. If a portion of either of these reagents were added to fresh blood, and examined carefully under the Microscope, they would, in all probability, find these starch-like bodies developed in the field. It was not easy to show the process in a room to a number of persons; but if any one present was interested in these subjects, he should be very glad to demonstrate what he had been describing.

Mr. Stewart inquired whether these bodies were supposed to be formed by the reagent, or were they supposed to be really present before, but only to be made visible by the reaction?

Dr. Ralph said that under favourable circumstances they might see a globule which they would be disposed to say was oil; when the reagent was added it would increase in size from about the $\frac{1}{3000}$ inch to about the $\frac{1}{1000}$ inch; later it would suddenly become

opaque, and then it would colour in such a way that any one looking at it would say at once that it was starch. So far as he had carried out the observations, it seemed as if these starch-grains really did develope, and he thought it might be an instance of the commencement of the process of amyloid deposit.

Dr. Morris, of Sydney, was introduced to the Meeting by the President, and detailed some experiments which he had made in mounting diatoms in phosphorus in such a way as not to be inflammable. As he had only just arrived from Sydney, he had not had time to write anything on the subject.* He had seen some of the specimens which had been mounted in England, and was under the impression that the solution was too strong. He proposed, therefore, to reduce it to such a strength that if a piece of white blotting-paper was put into it, it would not blaze up. By such a solution all difficulty as to using the medium was done away with, the only necessary precaution being to have a basin of water near at hand to dip the fingers into.

Mr. Stephenson said that if they used a weak solution they would get a lower refractive index, whereas the principal object in mounting in phosphorus was to get as great a difference as possible between the refractive index of the medium and that of the object, for on this difference alone the increase of visibility depended.

Mr. Crisp said that if phosphorus was used diluted to a refractive index of 1·7, the visibility of the diatom would be proportionately reduced, and as there was no virtue in phosphorus, except for its high refractive index, it would be better not to use it at all in such a condition, but to take some non-inflammable substance which had the lower refractive index.

Dr. Morris said that, with regard to the value of the process, he might mention that he had tried some *Naviculæ*, and that with an oil-immersion lens the object mounted in phosphorus was resolved in the most perfect manner—far superior to anything that could be seen with balsam.

Mr. Crisp said that it must be borne in mind that the danger incidental to the use of phosphorus was not confined to the process of mounting. A case recently occurred in which an object-glass, brought down too hard, broke the cover-glass, and the observer, having wiped off the exuding phosphorus with his handkerchief, put it into his pocket and set himself on fire.

Mr. Ingpen exhibited and described some high-power achromatic eye-pieces, by Steinheil, of Munich (Series A F). They were constructed for astronomical purposes, but he thought they would prove serviceable for use with the Microscope. Those exhibited were of $\frac{3}{4}$, $\frac{1}{2}$, and $\frac{1}{3}$ inch focus, each having a field of 40° (see p. 551). Mr. Ingpen said that, whatever differences of opinion there might be as to

* See note by Dr. Morris written after the meeting, *supra*, p. 579.

the value of deep eye-pieces, there was probably none as regarded the desirability of securing the best possible definition, whatever amplification was used. He considered that with Huyghenian eye-pieces of less than an inch focus there was a serious deterioration of the image. The eye-pieces now exhibited gave the sharpest definition of any of similar foci he had hitherto been able to examine.

Mr. Crisp explained the new method devised by Dr. Ehrlich, the assistant of Dr. Koch, for preparing the bacteria of tuberculosis, which constituted a considerable improvement upon the original process. It produces a more intense colour in the bacteria, so that they appear larger, and can be recognized with a lower power, even, it is said, of 250 diameters (see p. 572).

Prof. Abbe's process of increasing the consistency of pure cedar-oil, so as to render it less fluid and therefore more convenient for use as a homogeneous-immersion fluid, was explained by Mr. Crisp. The oil is spread out in thin layers, and exposed to the action of the air and light for a long time, until it becomes of the consistency of castor-oil (see p. 551).

Mr. W. F. Petterd's letter was read accompanying a collection of diatoms from Tasmania.

Mr. A. Certes' letter, reiterating his claim to the discovery of a method of staining the nucleus of *living* Infusoria, was read by Mr. Crisp, who said that the author of the interpolation by which such a claim was described as "erroneous," now agreed that he was mistaken in the view he had expressed, not having in fact sufficiently noticed that the claim related essentially to the nucleus of the *living* animals (see p. 576).

Mr. Crisp called attention to a process devised by E. Korschelt, of Freiburg, for preserving Infusoria and *Amœbœ* by the use principally of osmic acid and chromic acid, no method having hitherto been found for the latter organisms. Dr. A. Gruber had also succeeded in preserving Heliozoa by the method, in excellent condition (see p. 574).

Mr. R. Miller's description of his caoutchouc cement for making and sealing cells was read, in which he stated that he did not claim to have discovered any new material, but to have accidentally hit upon a new method of combination. The material so obtained was singularly easy to work, and reliable in its results (see p. 579).

Dr. Van Heurck's letter was read describing favourably his further experiences with the Swan electric lamps and Faure-Reynier accumulators (see p. 557).

Professor Abbe's note was read with reference to the description of his camera lucida, *ante*, p. 261, in which he stated that the benefit of the arrangement consisted simply in the ease with which it may be used. In other respects it did not possess any advantage over those forms which fulfil the condition that the image is seen without reflection or other loss of light.

Mr. Ahrens exhibited and explained the construction of his new erecting binocular Microscope. In general outline it presented much the same appearance as that of Mr. Stephenson, the tubes being inclined, whilst the stage was horizontal. The erection of the image was, however, obtained by introducing a Nachet erecting prism over the objective, another prism similar to the Wenham being used above to divide the pencils.

Dr. Millar said that, whilst he could speak with great praise of the advantages of the erecting binocular as an instrument to work with, leaving nothing to be desired for comfort and convenience, he thought the one now before them did not appear to give an entirely satisfactory stereoscopic effect.

Mr. Michael said there was no doubt that a binocular Microscope, with a flat stage and an erecting arrangement like that of Mr. Stephenson, was an immense help to those who worked at living objects. In drawing from living insects he had found it of the greatest practical service.

Professor Liversidge's communication on the "silver-fish" of Sydney was read, in which he defended the accuracy of the observations of Hooke recorded in his 'Micrographia' (1665) as against the strictures of Mr. W. Blades in his 'Enemies of Books' (3rd edition, 1881). Specimens of the insects were sent, and labels and sheets of paper destroyed by them exhibited (see p. 500).

Mr. Hartog said there was no doubt as to the animal being *Lepisma saccharina*, the same that was often found in this country. It was mentioned by Emerson Tennant as being thought by some to prey upon books, but the author was of opinion that it rather preyed upon the insects which were found in the books, a view which he (Mr. Hartog) considered an error.

Mr. Thom's letter on *Saccharomyces* was read, in which he mentioned that he had devoted all his spare time for ten years in tracking these organisms, and now made all his bread without any yeast, so called.

Mr. Bennett, to whom the letter was addressed, made some remarks upon the subject.

Mr. Badcock's note was read (in his absence from illness) as to his observation of eyes in the adult forms of *Melicerta ringens*, *M. tyro* (or *tubicularia*), and *Stephanoceros Eichhornii*, also as to the development of the latter form from the egg. He also pointed out that

the tube with advancing age got filled up with mucilage, until only just room enough was left for the creature to move up and down (see pp. 345–6 and p. 512).

Mr. Badcock's note was read as to a criticism by Professor O. Bütschli of his paper on Acinetina (this Journal, III. (1880) p. 561), which had appeared in the 'Zoologischer Jahresbericht' for 1880 (p. 173). Professor Bütschli, in remarking on Mr. Badcock's comparison of the finely ciliated newly-born *Podophrya quadripartita* to *Megatricha partita*, referred to the latter as a Rotifer (!), being apparently surprised that such a comparison should have been made. At first Mr. Badcock was puzzled to know how the reporter could have fallen into such a mistake, but it had since occurred to him that the explanation was to be found in the fact that there were Rotifers named *Megalotricha*, and although these were very large Rotifers, while *Megatricha* is one of the most delicate of all the Ciliata, it was most probable that this was the origin of the mistake.

Mr. Wilson thought it was strange that Professor Bütschli, who was a very eminent authority on the Protozoa, should not have been familiar with *Megatricha*, as appeared to be the case. Many of the reviews in the 'Zoologischer Jahresbericht' were, however, obliged to be hastily done, and some excuse must be made on that account, as well as for the fact that the reporters had to deal largely with papers written in foreign languages.

Professor Abbe's paper "On the Relation of Aperture to Power," Part II., was laid before the meeting by Mr. Crisp, who said that as it was a very long communication, he had prepared a *résumé*, which presented the leading points in a condensed form suitable for being read to the Meeting. This he was proceeding to do, when

Mr. Beck, interposing, said he thought that as the paper was an important one, and required a good deal of consideration, a *résumé* of it would be of very little use to them. He would suggest, therefore, that the paper should be printed, and that when it had been before them *in extenso*, an evening should be specially devoted to its consideration and discussion.

The Chairman (Mr. Glaisher, in the absence of the President), on the contrary, thought that it would be very useful to have an abstract of the paper read.

Mr. J. Mayall, jun., also thought it very desirable that the Society should be in possession of Professor Abbe's views, without having to wait until the next issue of the Journal.

The Meeting having indorsed this view, Mr. Crisp read a *résumé* of the paper (see p. 460).

The Chairman said that the paper was obviously one of very considerable importance, and he had great pleasure in proposing that the warm thanks of the Society should be presented to Professor Abbe for it.

Mr. Stephenson seconded the suggestion, and said that, having

had the advantage of reading the paper in MS., he was able to say that it contained a most exhaustive discussion of the subject.

Mr. Crisp said that it was the first attempt that had been made to establish a definite relation between aperture and power, and amongst other benefits it could not fail to prevent the perpetration in future of such absurdities as had been issued in the way of low-power objectives with very large aperture.

The Chairman said that the report of the committee appointed to consider the question of standard gauges for eye-pieces and substages had been adopted by the Council. The gauges recommended for eye-pieces were 1·35 inch and 0·92 inch, and for substages 1·5 inch.

The following is the report of the committee :—

"The committee who were appointed under a resolution of the Council directing them to 'consider the advisability of establishing standard gauges for eye-pieces and substages,' after communication with the leading opticians and with Fellows of the Society, now present their report as follows :—

"The committee have found that a very general desire exists on the part of workers with the Microscope that there should be *standard gauges* both for eye-pieces and substages, and the committee therefore resolved 'That in the opinion of this committee it is expedient that standard gauges should be established for the eye-pieces and substages of Microscopes.'

"In considering the question of the *number* of standards to be adopted, the committee were of opinion that it would not be practicable to establish a single uniform gauge for eye-pieces. On the one hand, a considerable number of Microscopes issued are of small size, and could not with convenience be fitted with a body-tube of large diameter ; while, on the other hand, it would be undesirable to reduce the diameter in use with first-class instruments. The same considerations do not apply to the case of substages, which are frequently of as great a diameter in the smaller instruments as in the larger. The committee, therefore, resolved to recommend 'That the standards for eye-pieces should be two in number, with a single standard for substages.'

"With regard to the *size* of the standards, the committee did not feel themselves able to treat the question as one entirely open, but considered that it would be preferable to select some sizes already in general use, so as to involve the minimum of change. They therefore resolved to recommend 'That the two standard gauges for eye-pieces should be, for the No. 1, 1·35 inch, and for the No. 2, ·92 inch (external diameter), and that the gauge for the substages should be 1·5 inch (internal diameter).' The No. 1 gauge is generally used for the larger instruments in England, whilst No. 2 is that adopted by many Continental makers."

Mr. Crisp said that it should be mentioned that there had been some difference of opinion, both on the part of the committee and the Council, as to whether there should not be a third intermediate

gauge; also, that in selecting the sizes mentioned by the Chairman, regard had been had to those which were at present in most frequent use, so as not to disturb existing arrangements more than could be helped.

The following Papers were taken as read:—

"Plant Crystals," by Dr. Aser Poli, of Rome.

"Note on the Rev. G. L. Mills' Paper on Diatoms in Peruvian Guano," by Mr. F. Kitton.

"On the Estimation of Aperture in the Microscope," by the late Mr. Charles Hockin, jun.

The following Instruments, Objects, &c., were exhibited:—

Mr. Ahrens:—New Erecting Binocular Microscope.

Mr. Bolton:—Spawn of Perch.

Mr. Crisp:—(1) Balkwill's Slide of Foraminifera. (2) Hardy's Compressorium (see p. 553). (3) Malassez's Compte-Globules (see p. 559). (4) Tolles' $\frac{1}{4}$-inch objective with very tapering front. (5) Tolles' Camera Lucida (see Vol. III. p. 527).

Mr. Ingpen:—Steinheil's High-power Achromatic Eye-pieces, $\frac{3}{4}$-inch, $\frac{1}{2}$-inch, and $\frac{1}{3}$-inch.

Prof. Liversidge:—"Silver-Fish" (*Lepisma*) from Sydney, N. S. Wales.

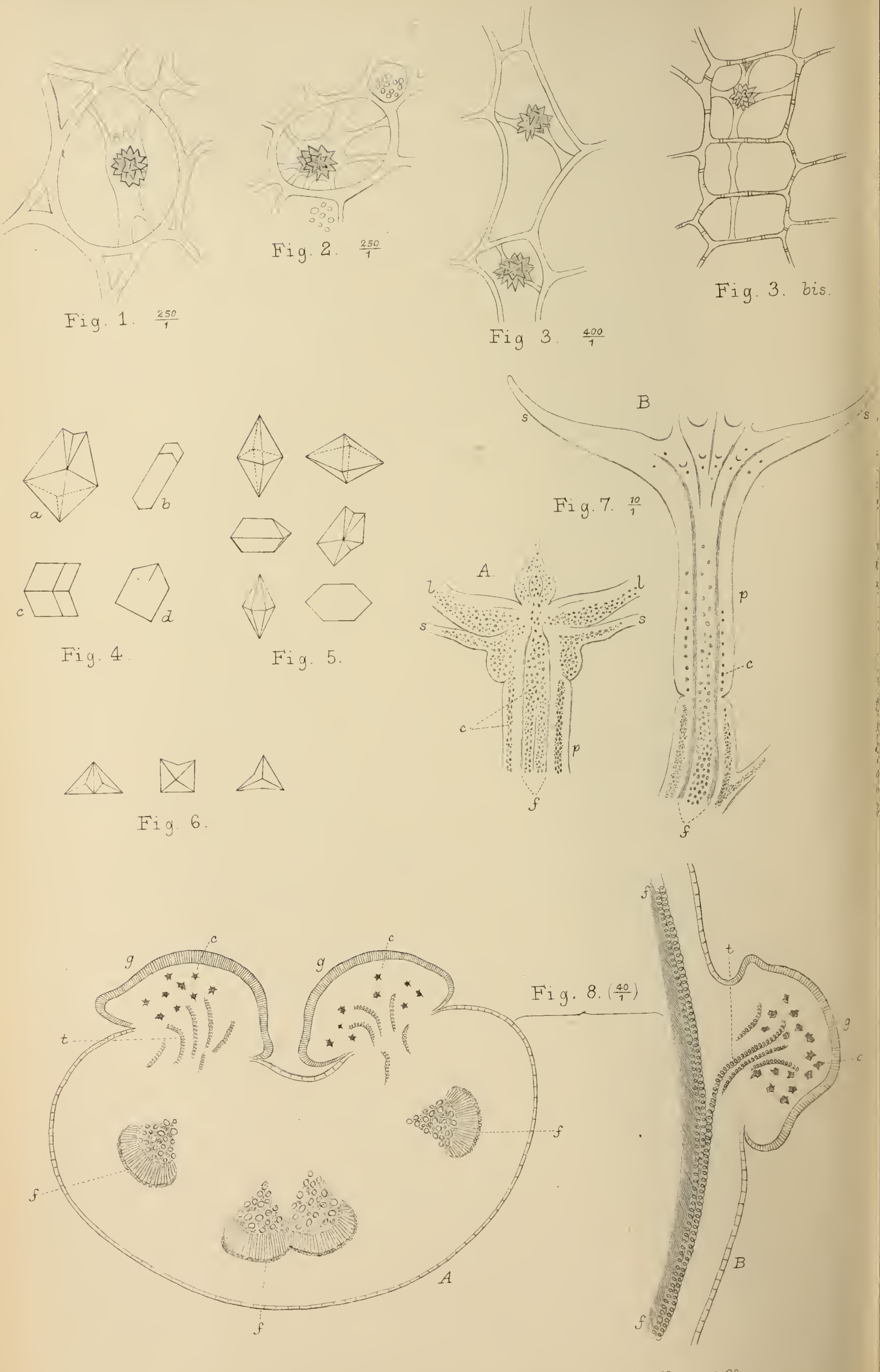
Mr. R. Miller:—Caoutchouc Cement.

Dr. Ralph:—*Vallisneria* from Melbourne.

Dr. G. M. Sternberg:—Photographs of Bacteria (see p. 571).

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. William Borrer, jun., William E. Pickels, John Rookledge, Thomas C. Squance, M.B. and M.S., and Prof. Albert H. Tuttle, M.Sc. (At p. 443 for Henry Pocklington read Christopher Pocklington.)

WALTER W. REEVES,
Assist.-Secretary.



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Plant-Crystals.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1882.

TRANSACTIONS OF THE SOCIETY.

XIV.—*Plant-Crystals.* By Dr. Aser Poli.

(*Read* 14*th June*, 1882.)

Plate VI.

Plant-crystals were first observed by Malpighi,* and afterwards by all phytotomists. But the earliest researches on their composition and anatomical distribution in many plants were made by Sanio (1857). Gulliver has also published, from 1859 to 1880, several papers on plant-crystals, and especially on their classificatory significance, but I am sorry to have found his works very little known, although they contain a great many very important observations. Holzner ('Flora,' 1864–69) studied the chemical composition, the crystalline shapes, and physiological significance of plant-crystals; and the other authors who have dealt with the subject are quoted in my work 'I cristalli di ossalato calcico nelle piante,' Roma, 1882.

I. *The Composition of Plant-crystals.*—We may say that almost all plant-crystals are of calcium oxalate. There are crystals of calcium phosphate and tartrate, of potassium oxalate,

EXPLANATION OF PLATE VI.

Figs. 1 and 2.—Rosanoff crystals in *Mercurialis annua* L.
Fig. 3.—The same in the pith of *Canothus Africanus* L.
„ 3*bis*.—The same in the pith of *Lavatera arborea* L.
„ 4.—Crystals of *Salvia rectiflora* Vis.
„ 5.—Crystals of *S. janthina*, Otto et Dtetr.
„ 6.—Crystals of the Solanaceæ.
„ 7.—Vertical sections. *A*, in a female flower of *Ricinus*; *B*, in a male flower; *c*, crystals; *f*, fibro-vascular bundles; *p*, peduncles; *s*, sepals; *l*, petals.
„ 8.—*A*, transverse section of the petiole of a seed-leaf of young *Ricinus*; *B*, vertical section of the same; *g*, glands; *f*, fibro-vascular bundles; *t*, vessels; *c*, crystals.

* Opera omnia, Lugduni Batavorum, 1687.

&c., but they are distinguished by their solubility in water, or in acetic acid. All plant-crystals which are insoluble in water and acetic acid, and soluble in mineral acids, are composed of calcium oxalate.

There are no crystals of calcium carbonate or sulphate in plants.*

Holzner has given a table for distinguishing the crystalline formations in plants by chemical reactions.†

II. *Crystalline form of Calcium oxalate.*—Calcium oxalate crystallizes in the tetragonal system, with three molecules of water; in the monoclinic system, with one molecule of crystallization water. The octahedrons are generally tetragonal (e. g. crystals of *Begonia, Tradescantia*, &c.); the short prismatic crystals, the raphides, and all those crystals which were believed to be of sulphate of calcium (e. g. the long prismatic crystals of *Iris*), are monoclinic.

III. *Forms of Plant-crystals.*—The various forms of plant-crystals have been described by Gulliver, who distinguished four principal forms: raphides, sphæraphides (*drusen* of the Germans), short prismatic crystals, and long prismatic crystals.

The raphides have been the principal object of Gulliver's researches. They are frequent in Monocotyledons, and are found also in some families of Dicotyledons. Gulliver has described them in Vitaceæ, Balsaminaceæ, Galiaceæ, and Onagraceæ, and in numerous other orders of plants, but in the British Exogens so confined to the last three orders as to be characteristic of them; *Hydrangea*, by its raphides, he finds sharply distinguished from the Saxifragaceæ, under which order it is usually placed; and *Montinia* by its want of raphides as plainly differing from its assigned order, Onagraceæ.‡

The other crystals may be found free and abounding in the cavities of plant-cells, or one in every cell. The little prismatic, or tabular crystals, and the simple octahedrons, which are in many Gesneriaceæ, Bignoniaceæ, Scrophularineæ and Labiatæ, belong to the first case. To this also belongs, I think, the *crystalline powder* of *Sambucus* and of many Solanaceæ. To the second case belongs the greatest number of plant-crystals, especially those which are grouped in *druses* (very common in the pith and bark of ligneous plants) and the short prismatic crystals of the bast-cells.

* But see Beale's 'How to work with the Microscope,' 5th ed. p. 174, plate xlvii. for Gulliver's description and figures of sphæraphides of carbonate of lime.—Ed.

† See "Bemerkungen zum Referate über Gulliver's Liste krystallhaltiger Pflanzen," von Prof. Dr. Georg Holzner, Zeitschr. f. Mikrosk., i. (1877), Heft 2, pp. 42–44.

‡ See this Journal, iii. (1880) p. 44; and Quart. Journ. Micr. Sci., 1866, and on Pollen, &c., in Pop. Sci. Review, 1868.

A very interesting form is that of crystals which are surrounded by an integument of cellulose, and fixed by this to the walls of the cell (see Pl. VI. Figs. 1, 2, and 3). They were seen first by Rosanoff (Bot. Ztg., 1865,) in *Ricinus* and *Kerria Japonica*, and afterwards in many Araceæ, in the fruit of *Rosa* (by Poulsen, who named them Rosanoff-crystals), in the pith of many Malvaceæ (*Sida, Hibiscus, Lavatera,* &c.) in the *Rigellaria Africana, Mercurialis annua*, and some Celastraceæ and Rhamneæ. These ligaments of cellulose are perforated, tubiform, and in the Malvaceæ they are found also in the cells which do not contain crystals, but in continuation of ligaments which surround the crystal of the contiguous cell (Fig. 3 *bis*).

Crystals are found also in the walls of cells, in the epidermic cells of many species of *Sempervivum* and *Mesembryanthemum*, and in the fibres of liber of many Coniferæ (Solms-Laubach and Pfitzer).

IV. *Plant-crystals as a Taxonomic Character.*—Crystals are not frequent in Cryptogameæ and Gymnospermeæ; but in the Angiospermæ they form the constant character of many families and groups of plants. Gulliver has proved the constant presence of crystals, and especially of raphides, in certain plants. He has found raphides in many orders, of which examples occur in Vitaceæ, Mesembryanthemeæ, some Nyctagineæ, in Balsaminaceæ, Onagraceæ, and Galiaceæ; and in the British flora he defines the Balsaminaceæ as Geraniales abounding in raphides, the Orchidaceæ as Gynandrous Endogens abounding in raphides, and Galiaceæ as Corollifloral Exogens abounding in raphides. Vesque * has found that the presence of raphides is a constant character of Dilleniaceæ. We may then define Dilleniaceæ as *Ranales* with raphides.

In the Lemnaceæ the genus *Lemna* contains raphides, the genus *Wolfia* is wanting in raphides. Vitaceæ contain every form of crystals in the stem, leaves, and fruit. Almost all ligneous plants contain sphæraphides in their pith and bark, and short prismatic crystals in the bast-fibres and sometimes in the wood (*Clusia*). Celastraceæ and Rhamneæ contain Rosanoff-crystals in the pith and the bark (Fig. 3). The bark and pith of many herbaceous plants (e. g. Labiatæ), contain free, abounding, little crystals. Many Monocotyledons contain only raphides (e. g. Orchidaceæ, *Narcissus*, many Liliaceæ, &c.); the *Iris* has long prismatic crystals, Araceæ raphides and sphæraphides. (In my abovementioned work there is a list of plants which contain crystals.)

V. As to the *physiological function* of crystals in plants we know very little. It seems that oxalate of calcium is a useless product of plants, because it is often eliminated from the plant by the fall of dead leaves and old bark; it is generally accumulated

* Vesque, "L'Anatomie des tissus appliquée à la classification des Plantes," Nouvelles Archives du Muséum d'Hist. Nat., iv. (1881).

in those parts of the plant, every function of which has ceased, and where it is formed it remains, and is not dissolved again. (In Dr. Beale's work above cited, are observations by Gulliver on the uses of plant-crystals.)

In the herbaceous plants, crystals abound in the axis of the inflorescence and stalks of flowers; and in *Ricinus* I have observed that there are an abundance of sphæraphides in the female flowers, while they are almost wanting in the male flowers (see Fig. 7). In small plants of *Ricinus*, crystals appear first in the glands of cotyledonary leaves by the side of the spiral vessels (see Fig. 8).

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Symbiosis of Dissimilar Organisms.†—G. Klebs, starting with the principle that the life of every organism is necessarily bound up with the life of others, directs attention to some of the general conclusions derivable from a study of symbiosis.

A great step in advance was made when P. J. van Beneden distinguished commensalists and mutualists from true parasites, even though these divisions and their definition may require some amendment. When one organism lives in or on another, this relation may be due to one of two sets of causes; we have cases in which only one of the organisms is more or less compelled to be associated for some part of its life with another; here we have the proper relation of host and guest, or one-sided adaptation. In other cases it is necessary, that the two symbiosists should live together, and here we have mutual adaptation, though one may be more dependent on its fellow than the other on it.

The author in what follows confines himself to the former set of cases, pointing out that the essential part of the relation is taken by the organism which seeks out the other, often larger, and often also more highly organized, for the purpose of fulfilling its own mode of life. Any one who has examined life in a pool or in the sea knows that almost every large organism, be it plant or animal, is covered with a number of smaller ones; this is the simplest case of symbiosis: smaller organisms make use of the surface of the larger one; thus algæ will be found covered with diatoms; every tree on land is beset with algæ, lichens, and mosses, and often there is a definite relation between them and the kind of tree on which they live. Various plants,

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Biol. Centralbl., ii. (1882) pp. 289-99.

especially algæ, attach themselves to snails or mussels, and even to such actively moving forms as *Cyclops* or *Daphnia*. Numerous examples of animals are then cited; such as *Vorticella*, *Epistylis*, Sponges, Hydroid Polyps, Bryozoa. In some cases (crabs and sponges) a rapacious host hides himself under the cover of his guest.

Cases of higher symbiosis, in which the guest is not external, are next entered upon, and it is pointed out that, in addition to all these cases in which the host is always passive, there are others in which there is some kind of reaction between guest and host; thus the crustacean *Cryptochirus coralliodytes* affects the streams of water which pass to the polyps of its coralline host; and corals are very frequently indeed affected in form by the crustacea or mollusca that give in them. In conclusion the author thinks that we gain but little information as to the cause of these symbiotic phenomena, if we are content to say with Van Beneden that there is a "sympathy" between the host and guest.

Electric Organs of Gymnotus.—G. Fritsch has two appendages to Sachs and du Bois Reymond's great work * on this fish, in which he gives an account of his histological and morphological investigations into the nervous and electric apparatus; he finds support for the doctrine that the electric organs of *Gymnotus* have been developed from transversely striated muscle, a portion, the lowest lateral muscles, having been separated from the rest to form the so-called intermediate muscular layer, while a superior mass of muscle was converted into the great electric organ. The two are surrounded by a common fascia, which separates them from the so-called small organ which owes its origin to a metamorphosis of the muscles of the fin-rays. No explanation can yet be given of the remarkable variations (within 50 and 100) of the number of electrical columns. Every electric plate of *Gymnotus* arises from a certain number of primitive muscular bands which become connected together in their middle; the separate pieces of the compound plates do not, however, seem to correspond to a primitive bundle, but to a primitive cylinder (Cohnheim) of the embryonic muscle. The mode of termination of the nerves may be most nearly compared with what is seen in the pseudo-electric organ of *Raja;* the spongy tissue around the nerve-endings and "thorny papillæ" is a supporting substance, directly continuous with the sheath of Schwann.

In the description of the central nervous system attention is directed to the rounded form, well-developed cell-protoplasm, and broad attachment of the process of the axis-cylinder in the characters of the fully developed electric cell.

B. INVERTEBRATA.

Intracellular Digestion.†—E. Metschnikoff directs attention, in this connection, to the hydroid parasite found by Owsjannikoff in the egg of the sterlet; in the endodermal cells of that parasite were to be

* 'Unters. am Zitteraal' (Sachs und du Bois Reymond) 446 pp. (8 pls.) 8vo, Leipzig, 1881.

† Zool. Anzeig., v. (1882) pp. 310–6.

seen small highly refractive granules, which "undoubtedly owed their origin to nutrient matters taken into the interior of the cell." The author is of opinion that in the Turbellaria and Cœlenterata (inclusive of Sponges) intracellular digestion is the general rule; a very suitable form for its demonstration is stated to be young Ctenophores, for in them the whole process can be followed out to the end (i. e. till the time when crystalline concretions appear within the vacuoles) in one and the same individual. The opinion of Krukenberg that colouring matters are indigestible, is not supported by the author's observations, carmine, for example, being distinctly absorbed; and Eisig has lately shown that carmine is digested in the intestinal canal of the Capitellidæ and excreted by their segmental organs. Some other remarks of Krukenberg are closely criticized, and are regarded by Metschnikoff as not really affecting the reality of intracellular digestion in the lower forms.

Mollusca.

Nervous System of Mollusca.*—W. Vignal finds that the nerves are surrounded by a sheath of connective tissue of some thickness, which is formed of imbricated lamellæ, containing a number of nuclei; in the terrestrial pulmonate Gasteropoda the true sheath is invested in a second, formed of a layer of vesicular cells, which is not however, proper to the nerves, as it is found also on the vessels. From the true sheath there are given off a number of partitions, made up of several lamellæ, which pass towards the centre of the nerve; as they do so the lamellæ divide afresh and unite one with another to form spaces of various sizes, in which we find the axial portion of the nerve-fibrils, and the protoplasm which surrounds them. While there are a number of nuclei in the partitions there are none in the protoplasm: the sheath is not to be compared with the sheath of Schwann in the Vertebrata, but if it is to be compared with anything found in that phylum, it must be with the intrafascicular connective tissue. This peculiar structure of the envelope of the nerve-fibres is, it is remarked, found very generally among the Invertebrata, something analogous being found in both Hirudinea and Lumbricidæ. Its presence affords an explanation of the difficulty of dissecting out any length of nerve-fibrils. These fibrils themselves spread over the surface of the ganglia and penetrate some way into their interior; in this region the protoplasm contains a number of fatty and pigmented granulations, which would appear to form a reserve used up by the animal in the winter, as they are much more numerous (in *Helix*) during the summer than they are at the end of the period of hibernation.

The author finds that for the demonstration of the partitions chloride of gold is the best reagent, for they are coloured by it while the nerve-fibres are almost unstained; if the section is then decolorized by cyanide of potassium, and afterwards treated with picro-carminate of ammonia, the nuclei are very easily seen. The fibrils are best demonstrated by a mixture (in equal parts) of osmic and chromic

* Comptes Rendus, xcv. (1882) pp. 249–51.

acids; after it has been used for the specimens hardened in alcohol, the sections may be coloured by hæmatoxylin, and afterwards decolorized by very dilute formic acid.

North-American Cephalopods.*—Professor A. E. Verrill has published the second portion of his paper,† in which he deals chiefly with smaller forms, though the commencement is occupied by an account of a young example of the gigantic *Architeuthis harveyi*.

Observations on the habits of squids tell us that the fish captured are devoured with great rapidity, and it would seem that the jaws are the principal organ, while the odontophore plays only a subordinate part. The differences in anatomical structure between *Loligo* and *Ommastrephes* are carefully pointed out; in the latter there is not one large, but two small oviducts, and the nidamental glands are smaller and simpler; though, it is to be remembered, they were not examined in the breeding season.

A new genus, *Chiloteuthis*, allied to *Enoploteuthis*, is formed for a creature with a very complicated armature; the sessile arms have sharp incurved claws, arranged in four rows on the ventral arms, and in two rows on the others; other characters are detailed and an account is given of *C. rapax* n. sp. The family Desmoteuthidæ is formed for genera which have been confounded hitherto with the Crambidæ and Loligopsidæ; *Desmoteuthis* n. g. has for its type *Leachia hyperborea*.

The sexual differences in *Loligo pealei* are examined, and it is stated that the hectocotylized condition of the arm in the male is, contrary to the opinion of Steenstrup, developed in proportion to the development of the internal organs, and is not noticeable in the youngest males. Notes on the development and rate of growth follow.

A new species of *Rossia* (*R. megaptera*), remarkable for the great size of the fins and eyes, and for the length of its tentacular arms, was taken off the southern coast of Newfoundland. It appears to be a species adapted for greater depths than its congeners.

Another new family is that of the *Alloposidæ*, allied in some respects to *Philonexis* and *Tremoctopus*. The arms are extensively webbed; the mantle-edge, as in *Desmoteuthis*, is united directly to the head.

In an appendix the author describes several other new forms, and enters into some critical remarks on the work of other naturalists.

Marginella and the Pseudomarginellida.‡—J. Carrière commences with a notice of the four zones found at the island of Goree, each of which has its own fauna, different to that of the other zones. In the deepest we find, among other molluscs, *Marginella glabella*. The statement of Adanson that *Marginella* is to be found in the upper zone is not exact, for the shells there found, and so called, belong to quite a different kind of mollusc. Till lately the animals which

* Trans. Connect. Acad. Sci., v. (1882) pp. 259–446 (28 pls.).
† The first portion in tom. cit. pp. 177–257.
‡ Zeitschr. f. wiss. Zool., xxxvii. (1882) pp. 99–120 (1 pl.).

inhabit these shells have not been detected, and the resemblance between the shells of the upper and those of the lowermost zone are so close that no conchologist is to be blamed for associating them with one another. On closer examination, however, of the internal structure, very important differences are to be detected, and the whole account is so instructive that we give a *résumé* of the author's table of differences.

The three forms may be distinguished as *M. glabella*, *Pseudomarginella leptopus*, and *P. platypus.* In all cases the shell is that of *M. glabella*, but while the foot of the form properly so called is broad, flat, and tapers posteriorly, being red in colour, that of *P. leptopus* is narrow and high, of the same breadth throughout, and colourless, save for black spots at the sides, and that of *P. platypus* is broad, flat, the same breadth throughout, and colourless. So, again, the operculum is either absent, or is like that of *Fusus* (unguiculate), or is lamellar, as in *Purpura.* The tentacles of *Marginella* are long, the radula has only the middle plates, and these are broad and provided with a number of small teeth, while the pedal gland is large in proportion to the foot. In both Pseudomarginellids the foot-gland is very small; in *P. leptopus* the tentacles are short and broad, while in *P. platypus* they are short and round. The lateral plates of the radula are, in the former, broader than the median plate, but in the latter they are unciform and much smaller. Indeed, *P. leptopus* appears to belong to the Buccinacea, while *P. platypus* is probably one of the Purpuracea.

It is pointed out that, thanks to the investigations of Semper, we know that the very opposite of the conditions here described may in some cases be found to obtain; that is to say, there are forms (*Chlorœa* and *Dorcasia*) in which, though the animals are closely allied, the shells themselves are very different. The studies of later years show that shells with a large wide orifice are very variable; and now we find that *Marginella* is a form with a narrow orifice. The author insists on the important bearing which observations of this kind have on the determinations of palæontologists and the theories of stratigraphical geologists.

Vascular System of Naiades and Mytilidæ.*—Dr. H. Griesbach gives a preliminary notice of his studies on this subject, which has always attracted much attention, in association with the taking of water into the body of these molluscs. The animals were placed in water coloured by green iodide; and the coloration was sooner or later noticeable in the foot, whence it extended into the most various regions of the body. Owing to the chemical changes which take place in *Anodon*, owing to the presence in its tissues of a large quantity of calcareous salts, the tissues will be found to be coloured violet. The author has been able to force injections through the slit-like orifice in the foot (one of which lies quite anteriorly, and the other two at about the middle). The colouring matter may be observed to pass not only into the larger trunks, but also, with care and patience, may be detected in the vessels of the muscles of the foot.

* Biol. Centralbl., ii. (1882) pp. 305–9.

The author promises to give further details, and to demonstrate how the openings are connected with the blood-passages. He regards the water that is taken as having a respiratory as well as an erectile function.

Sexuality of the Oyster.*—M. Bouchon-Brandely points out that, while the common oyster (*Ostræa edulis*) is hermaphrodite, the Portuguese form (*O. angulata*) is unisexual. In the latter the ova are expelled from the shell and fertilized in the water. The characters of their development are such as to yield no support to the doctrine of hybridization taught by some French ostreiculturists, and artificial fertilization of the two species has never yet been found to be successful. Artificial fecundation of *O. angulata* was, however, effected, and it was observed that the shell is formed on the sixth or seventh day after impregnation. The genital gland of this species does not have its elements matured until the time when it becomes transparent. Having been successful in small attempts at artificial fertilization, the author has successfully attempted some experiments on a much larger scale.

Arthropoda.

α. Insecta.

Respiratory Movements of Insects.†—F. Plateau finds, as the chief results of his experiments, that—

1. There is no close connection between the character of the respiratory movements of an insect and its systematic position. The respiratory movements are only analogous when there is very nearly the same structure of the abdominal rings, and of the muscles which move them. For example, the respiratory movements of the Phryganida do not resemble those in allied Neuroptera, but are much more similar to those of the aculeate Hymenoptera.

2. In *all insects* the diameter of the abdomen diminishes during expiration, owing to the approximation of the tergal and sternal pieces. The former, as in the Coleoptera, may alone be mobile, or the latter, as in Acrididæ, Libellulidæ, Lepidoptera, and Muscidæ; or the two may move equally, as in Tipulidæ, *Sialis*, and a few others.

3. The modifications in the vertical diameter *may* be accompanied by changes in the transverse diameter, as in the Libellulidæ, Chrysopidæ, some Coleoptera, &c.

4. Contrary to what was formerly believed, it has been found that, during normal respiration, changes in the length of the abdomen are rare; they are to be seen in the aculeate Hymenoptera, and in such isolated cases as the Phryganidæ among the Neuroptera, and the Coccinellidæ among the Coleoptera.

5. In most cases the thoracic segments take no share in the respiratory movements when the animal is at rest, but they have been observed to do so in some genera of Coleoptera.

6. Contrary to the opinion of most observers, M. Plateau thinks that the respiratory wave is an exceptional phenomenon. It has not

* Comptes Rendus, xcv. (1882) pp. 256–9.
† Bull. Acad. R. Sci. Belg., iii. (1882) pp. 727–37.

been observed in any of the Coleoptera, the Acridida, *Libellula*, aculeate Hymenoptera, Muscidæ, and all Lepidoptera.

7. When there is a pause it is almost always during the inspiratory phases.

8. In large forms, suitable for such investigation, it has been observed that inspiration is ordinarily slower than expiration, and that the latter is often very rapid.

9. In most insects expiration only is an active movement, while inspiration is passive, and due to the elasticity of the integument, and of the walls of the tracheæ.

10. Inspiratory muscles are rare, but have been found in the Phryganidæ, as well as in the Hymenoptera and Acrididæ.

11. The so-called upper diaphragm, or *alœ cordis*, as well as the lower, have not the function attributed to them by Wolff.

12. A large number of insects, perhaps all, impress on their abdomen general movements, which vary in intensity, but do not coincide with the respiratory movements proper.

13. These last are purely reflex, and persist after decapitation, and even (when the nervous system is not concentrated) when the abdomen itself is isolated. In it the movements may be hastened or retarded by just the same external causes as produce the same phenomena in the uninjured animal.

14. The metathoracic ganglia are not special respiratory centres.

15. The abolition of the respiratory movements, on the destruction of the metathoracic ganglia, which is to be seen in *Dytiscus* and some other Coleoptera, is due to the concentration of their nervous centres, some abdominal being fused with the thoracic ganglia.

16. In insects with a concentrated nervous system, the excitation or partial destruction of a complex nervous mass affects all the centres which enter into the composition of it.

These important and interesting results are due partly to the use of the "graphic method," the movements being inscribed on a rotating blackened cylinder. In addition to this, a "method by projection" was used. An insect fixed by a slight support, and in such a way as not to affect its respiratory movements, is introduced into a large, well-illuminated magic lantern. The objects of the investigation—the respiratory movements—are then thrown upon a screen, whence they can be drawn on a sheet of paper. Displacements of a fraction of a millimetre can thus be followed. This latter method is a modification of that of Professor Valerius. Further details will be given in the complete memoir, of which this is only a preliminary notice.

Location of Taste in Insects.*—J. Künckel and J. Gazagnaire have studied minutely the anatomy of the *epipharynx* (labrum of authors) and *hypopharynx* in the Diptera. They form two troughs, whose concavities are opposite each other, the hypopharynx being embraced by the margins of the epipharynx. In *Volucella* the walls

* Comptes Rendus, xciii. (1881) pp. 347–50.

of the latter become less rigid towards their margins, which are membranous. Just above them the internal face of the organ is beset with small modified hairs, arranged with regularity; the anterior end is armed with six pairs of straplike organs, jointed at the base and minutely spined, some of which serve to sweep pollen from the corollæ of flowers; the ventral pair carry 10 or 12 modified hairs in front of the joint.

Passing by the arrangement of the muscles in the epipharynx, we come to its nerves. They are derived from the supra-œsophageal ganglia; about half-way along the epipharynx they approach the middle line and break up into a number of fibres which are connected with the modified hairs which occur on the extremity, other fibres having been already distributed to the hairs which fringe the margins of the epipharynx. At the base of these hairs (which are button-like and placed on pointed chitinous processes) the neurilemma forms small swellings, and the axis-cylinder ends in a fusiform cell provided with nucleus and nucleolus, whose distal extremity becomes attenuated and terminates at the base of the protuberance which surmounts the button.

The hypopharynx has its membranous ventral wall reflected over the dorsal wall of the labium and covered with small hairs; its anterior extremity carries five spines. The space between its two walls opens towards the labium in front, and to the pharynx below; at this point the salivary duct also opens, and the salivary secretion is thus liberated opposite to the very spot on the epipharynx above, on which the terminal nerve-endings are situated. By this arrangement the saliva, charged with digested matters, meets these nerve-endings and evokes in them a gustatory sensation from the matters which it holds in solution. Taking this in connection with facts previously determined, it seems reasonable to conclude that gustation in the Diptera commences with the paraglossæ, at the point at which the false tracheæ open, is continued along the false tracheæ and becomes intensified at the extremity of the epipharynx, where quite a bouquet of nerve-endings occurs; it is prolonged along the margins of the epipharynx and operates at the entrance or throughout the cavity of the pharynx.

Parthenogenesis in the Bee.*—G. Ulivi considers that parthenogenesis in the bee is a myth, the result of his observations being as follows:—

1. Queens are usually fertilized inside the hive. On their return from the so-called "marriage-flight" they had empty spermathecas, while the act of fertilization was repeatedly witnessed in the hive.

2. They are fertilized several times.

3. Drones are not mutilated in the act of copulation. No lacerated drones were found after several careful examinations of all the drones in hives in which impregnation had taken place, and the whitish appendage attached to the queen's abdomen on her return from the "marriage flight" was found to consist of excreta.

* Amer. Natural., xvi. (1882) pp. 680–1, from the report of G. F. Krœh in the 'Scientific American,' 25th March, 1882.

4. Every egg that hatches into a male or female has been previously fecundated. Queens that had been allowed to fly were afterwards confined in hives containing no drones or drone brood, and either laid no eggs, or laid eggs that did not hatch.

5. Every queen whose spermatheca is distended and filled with liquid has been fertilized.

6. The eggs of a queen that has never met a drone will not hatch.

7. There is no such thing as a fertile worker. Fertile eggs will keep through the winter and hatch in the spring, and this hatching of fertilized eggs in queenless colonies has led to the belief in fertile workers.

"The investigations," writes W. N. L.* "appear to have been carefully and thoroughly conducted, and every result is based upon repeated observations. Should they be confirmed, not only will the theory and practice of bee-keeping be revolutionized, but another example will be added to the many that go to prove how slow mankind should be to accept as true, conclusions opposed to the ordinary laws of life. The continued reproduction of the aphides, sometimes called parthenogenesis or virgin maternity, is really of a very different nature. It is a process of budding differing from the budding of a zoophyte chiefly in the fact that it takes place upon an internal instead of upon an external surface."

Eye of Chloe diptera.†—In this Ephemerid, according to G. V. Ciaccio, the male, in addition to the compound eyes and ocelli of the female, has two large accessory compound eyes. He has discovered that these eyes "are distinguished in a marked manner from the ordinary ones, not so much by differences in their colour and form and the greater size of the crystalline cones, as by the fact that the optic rods do not consist each of a single piece but of two differently shaped and quite distinct portions, the one anterior, the other posterior." The first has the form of a six-sided prism and is about the same size as the rods of the ordinary eyes; it consists of a whitish filament containing a coloured granular substance. The second is a single filament, endowed with a peculiar refractive power, and is a prolongation of the first. In order to reach their respective cones, all the filaments traverse together a substance composed of large granules of a dirty white colour, verging on yellow.

In the stemmata, moreover, there is a large biconvex crystalline lens, placed just behind the cornea, which is curved, thin, and "tessellated behind with small cubical cells." It also seems to Ciaccio worthy of careful consideration, as not hitherto noticed in other insects, that the lens is not chitinous, but consists of a peculiar, rather soft substance, fairly transparent, containing a reticulation of very delicate fibres, with round or oblong nuclei placed at the nodes of the network. There is no capsule to the lens; its place is taken by a substance of the same character as that of the lens, but denser towards

* Amer. Natural., xvi. (1882) pp. 680–1.

† Rendic. Accad. Sci. Bologna, 1880–1. Cf. Bull. Soc. Entomol. Ital., xi. (1882) p. 154.

the periphery. The lens is kept in its place by a very delicate fibrillated tissue, perhaps representing the vitreous humour, intercalated between the lens and the retina. The latter, like the simple eyes of the Diptera, is composed of rods and large fusiform cells, each of which is continuous with a fibre of the optic nerve.

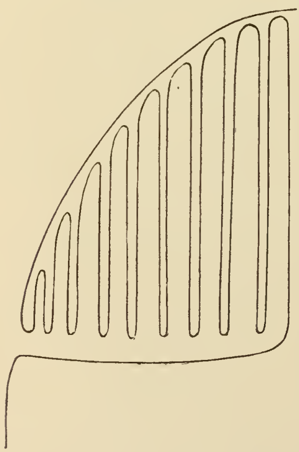
Marine Caddis-fly.*—Mr. R. M'Lachlan describes and figures the larva of a caddis-fly (*Philanisus plebejus* Walker) which inhabits rock pools between high and low water marks in New Zealand, and forms its case of coralline sea-weed. No truly marine form has hitherto been recorded, though at least one species lives in the brackish water of the shores of the Baltic, and several are found in salt marshes or pools occasionally invaded by the sea.

γ. Arachnida.

Respiratory Organs of Arachnids.†—J. Macleod, in a preliminary account of his observations on these organs, commences by stating that his earlier researches had led him to regard the lungs of Arachnids as a special form of trachea, or, in other words, as modified tracheæ, and in support of this it is pointed out that, while the tetrapneumonous Araneids have two, and the dipneumonous forms one pair of lungs, the latter have a pair of tracheal stigmata, comparable to the same organs in insects.

The lungs may be regarded as consisting of a cavity or chamber, the hinder portion of which opens to the exterior by means of a transverse slit, the lips of which are provided with a thickened chitinous pad; the chitinous lining of the cavity is continuous, at the stigma, with the cuticle of the external integument. Into the cavity there extend the lung lamellæ; each of these is composed of two chitinous layers, the spaces between which are occupied as blood-passages; for all the passages there is a common vestibule (Fig. 109), and the slits of all are similar to one another, with one exception; the last, instead of being cylindrical, is more or less triangular, its chitinous cuticle is thick and carries a large number of spines well developed, and so arranged as to form a kind of second tunic.

Fig. 109.



With regard to the tracheæ in the Araneida, we see that they may be simple or branched, and their stigmata confluent or separated. In an *Argyroneta*, in which they are well developed, there are two large cylindrical primary trunks, which open to the exterior by two

* Journ. Linn. Soc. (Zool.) xvi. (1882) pp. 417–22 (5 figs.).
† Bull. Acad. R. Sci. Belg., iii. (1882) pp. 779–92.

slits confluent along the middle line, and which give off a number of ramifications; the wall of each primary trunk is composed of an external chitinogenous wall, and an internal chitinous layer, covered by a large number of spines which unite with one another as in the last tube of the lung. The author believes that the tracheæ of *Argyroneta* are nothing else than the last slit of the second lung of *Mygale*, enormously developed, while the rest of the organ is obliterated.

A comparison between the lungs of Arachnids and the gills of *Limulus* is then entered upon, in which especial attention is directed to the work of Prof. Ray Lankester, which we have already noticed;

Fig. 110.

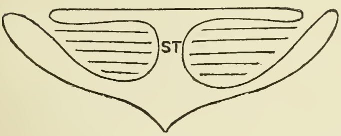
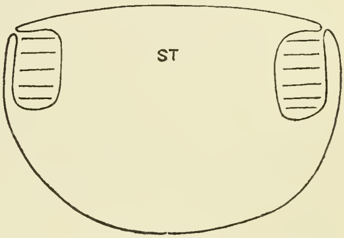


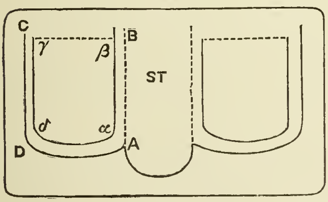
Fig. 111.



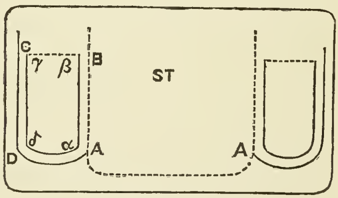
M. Macleod agrees in regarding the organs as homologues, but he thinks that their relations may be explained more simply than they

Fig. 112.

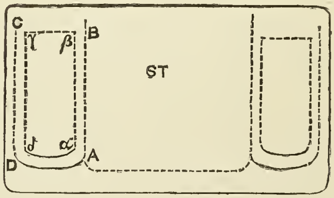
a



b



c



have been by the former. Let us begin by supposing that there is a considerable elongation of the abdomen of the *Limulus*, without any other change; the result of this modification would be that the respiratory limbs would no longer imbricate (Fig. 110). If, now, the sternal region should enlarge and fuse for its whole length into the ventral, while the infero-superior axis were elongated, we should arrive at the abdomen of a scorpion, where each lung was replaced by a gill (Fig. 111). Each gill would be composed of a quadrangular plate fixed by its intimal edge A B, and its anterior edge B C (Fig. 112*a*), and free on the other two; this plate would serve for the

insertion of a certain number of delicate quadrangular lamellæ, only fixed along the edge $\beta\gamma$. If the animal passes to a terrestrial mode of life the flaccid lamellæ, which were previously supported by the water, will apply themselves to one another, and will only be very imperfectly in contact with the air. They will become attached by their faces. [The three diagrammatic figures represent the modifications which have probably been undergone by the gill of a *Limulus* in becoming converted into the lung of a scorpion. *a Limulus*, *b* an intermediate stage, *c* a scorpion, *st* sternal plate, A B C D respiratory limb, attached by A B to the sternal plate, $\alpha\beta\gamma\delta$ respiratory lamella. The dotted lines indicate where fusion has taken place, the black ones the presence of a free chitinous edge $\alpha\beta$ and $\gamma\delta$ to the wall of the depression in which they are placed. The chitinous plate (modified limb) which covers them will fuse by its external edge C D to the edges of this depression.]

Limuli
(Five pairs of branchiferous appendages)

Passage to terrestrial mode of life. The first pair of respiratory limbs loses its function. The four following are adapted to aerial respiration.

Scorpions
(The two hinder lungs disappear)

Telyphonus.

The rings of the abdomen fuse.

Tetrapneumones.

The second pair of lungs converted into tracheæ.

Dipneumones.

In conclusion, doubt is thrown on the protracheate nature of *Peripatus*, and the suggestion is made that the respiratory organs of the Arachnida are not homologous with those of the Insecta.

Habits of Scorpions.*—Professor E. Ray Lankester records some interesting observations which he has recently undertaken on *Androctonus funestus* and *Euscorpius italicus.*

Of *Androctonus* he relates their mode of burrowing in sand, making horizontal tunnels which are often as much as 8 inches long. They commence by pushing the large chelæ into the sand and scraping very rapidly backwards with the three anterior pairs of walking-legs, this use of the legs comparing with the parallel but not identical use of the legs in *Limulus.* They were evidently timid, hiding in the daytime. Their carriage is remarkable, as in walking they raise their body well from the ground, the tail reflected over the back, and the sting carried just over the cephalic shield ready to give

* Journ. Linn. Soc. (Zool.) xvi. (1882) pp. 455–62 (3 figs.).

a forward stroke, the large chelæ widely outstretched and held horizontally, the creature feeling its way with them. They only feed at dusk or at night. The prey is seized by the left chela, and at the same moment the sting is swiftly brought over their head and the victim pierced with it. The short chelicerae are then inserted into the soft substance of the prey and the nutriment brought to the mouth by alternate movements of the right and left chelicerae. The combs or pectiniform appendages ordinarily do not appear to possess any special sensitiveness, but they may possibly become more so during the breeding season. The well-attested statement of the suicide of the scorpion when surrounded by a ring of red-hot embers, may perhaps be explained by the fact of some individuals accidentally lacerating themselves with their sting when half suffocated; Professor Lankester having seen a scorpion under the influence of chloroform vapour make repeated blows with its sting in the forward direction straight above its head until the top of the sting caught under the free projecting margin of the posterior region of the cephalic shield.

The body of *Euscorpius* is kept close to the ground, the legs extended on either side, the tail being dragged behind with the slightest upward curvature only, or one to the right or left. In fighting one another the large chelæ were used but never the sting. In stinging their prey they do so with great deliberation, the slowness of the process being perhaps due to the fact that the poison-glands have to be compressed by their proper muscles, and the poison squeezed out of the lumen of the gland after the sting has pierced the prey.

Nest-forms of the Furrow Spider.* — Dr. H. C. M'Cook has observed that some of the orb-weaving spiders have a marked tendency to vary the forms of their nests. The spinning-work of spiders may be classified as (1) the *snare*, spun for the capture of prey; (2) the *enswathment*, by which insects are disarmed and prepared for food; (3) the *gossamer*, used for purposes of aqueous or aerial locomotion; (4) the *cocoon*, spun for the propagation and protection of the species; and (5) the *nest*, which is a domicile more or less elaborate and permanent, within or under which the araneid dwells for protection against enemies and weather-changes. As a rule the great groups of orb-weavers differ from each other and agree within themselves in the characteristic form of nest. The form prevailing in each family is substantially the same; each species appears to adhere quite steadily to one characteristic form; but there are some marked variations in the habit of certain species, the most decided of which have been observed in the case of *Epeira strix*, the furrow spider. He gives some examples of this.

The ordinary nest when domiciled in the open field or wood is a rolled leaf. A second form varies from the rolled-leaf nest in having the edges of two adjacent leaves bent towards each other and lashed together on the exterior at the juncture by silken cords and on the interior by adhesive tissue web. An oval opening is left at the united

* Proc. Acad. Nat. Sci. Philad., 1882, p. 97.

points of the leaves, through which the connecting-line passes to the snare. The spider domiciles within the leafy cavern thus formed.

Again, the spider avails herself of small holes in wood or stone, openings in fences, the interspace between curled bark on the trunk of old trees, or some like cavity, which she appropriates as a nesting-place.

Another variation was due to an accident in the environment of the web. A colony of carpenter ants dropped their chippings on the web until a ball as big as a walnut had accumulated, which was then utilized by the spider as a nest, the interior being bored and silk-lined.

Other special variations are noted, including that of the nest attached to exposed parts of human habitations, such as the cornices of porches, outhouses, &c., and "it is thus seen that while there is a general regard to protection of the spider's person, there is a modification over a quite wide degree of variation in the form of the protective nest; further, that this modification appears to be regulated, more or less, by the accidental environment of the domicile, and in such wise as to show no small degree of intelligence in adapting the ordinary spinning habit to various circumstances, and to economizing labour and material."

Parthenogenesis in the House Spider.*—Mr. F. Maule Campbell details some interesting observations on a probable case of parthenogenesis in *Tegenaria guyoni*, one of the females of which, after a confinement of eleven months, twice moulted and afterwards laid eggs which were duly hatched. This shows either that she was impregnated previous to the casting of the two exuviæ, in an early and therefore immature stage, or that parthenogenesis occurs in the Araneidea. Hitherto no instance of virgin production has been recorded in the true spiders, though Mégnin, Kramer, Haller and Michael have shown that the females of some Acarina couple with the males prior to their final moult, and that practically there are two stages of sexual maturity. Beck and others have also related cases of undoubted parthenogenesis in the *Acari*.

Segmentation in the Mites.†—P. Kramer describes the segmentation of a minute mite, *Alycus roseus*. The dorsal aspect shows a very distinct segmental line between thorax and abdomen. The abdomen shows nine distinct segments, which follow one another exactly as in *Podura*. The segmental grooves between the first three are broad, and present somewhat the appearance of double lines, of which the anterior cut off the preceding segment, and the posterior commence the succeeding one. The lateral margin of the abdomen shows distinctly the convexities and constrictions which correspond to the middles and boundaries of the segments. The setation throughout follows the segmental conditions. The hindermost segment bears the perfectly terminal anal aperture, half of which

* Journ. Linn. Soc. Lond. (Zool.) xvi. (1882) pp. 536–9.

† Arch. f. Naturg., xlviii. (1882) pp. 178–82 (figs.). Ann. and Mag. Nat. Hist., x. (1882) pp. 183–4.

is seen in the dorsal view, while the other half is seen in the ventral.

On the thorax there is a distinct pair of eyes, furnished with very convex lenses, just as in *Rhyncholophus.* It further bears several long setæ, of which the pair situated between the eyes is distinctly fringed. This special pair of setæ on the thorax when seen under a low power, especially as it is placed near the black eye-spots, leads one to suppose that we have here a respiratory organ, similar to the stigma of the Oribatidæ; but a higher power shows distinctly that they are nothing but an ordinary capillary structure. On the thorax there are also three longitudinal lines, branched in a tree-like fashion behind, and two transverse lines; and these divide its whole dorsal surface into several areas, three of which occupy the entire central space.

On the lower surface the thoracic segmental lines are seen distinctly running between the coxal plates of the second and third pairs of legs. The segmental lines of the back also pass on to the lower surface bending forward in the middle of the abdomen. The segmental lines of the more anteriorly situated abdominal segments could not be distinctly traced on the lower surface.

δ. Crustacea.

Perception of Colour by Crustacea.*—C. De Merejkowsky following Sir John Lubbock's investigations into the perception of colour by the lower animals, has experimented on Crustacea, especially larvæ of Cirripedes and a Copepod. In darkness, the animals disperse to all sides of the vessel in which they are kept; if daylight is admitted through a slit, they congregate near the slit, and behave similarly towards monochromatic light, of whatever colour. Using two slits at an angle of 40° with each other and admitting white light by one and a monochromatic light by another, he finds that most, if not all, prefer the white light, but pale colours (yellow, green, pale red) also attract a few individuals. When two monochromatic lights are used, the brighter is preferred; with two rays of equal brightness the animals are equally divided between the two. Any superiority in the amount of light admitted attracts the bulk of the colony, whether the light is monochromatic or not. Thus it is seen that these animals appreciate only the quantity of the light, or the intensity of the vibrations which produce it, and are only sensitive to colour as implying a certain amount of light.

Mediterranean Crustacea.†—L. Joliet describes a parasitic Crustacean which he found under the form of small, ovoid, reddish bodies in the general cavity of the Alcyonarian *Paralcyonium elegans.* Not at all unlike a tardigrade at first sight, their two pairs of antennæ and the form of the hinder end of their bodies showed that they could be nothing else than crustaceans. The author soon found that the creature under examination belonged to the genus *Lamippe*, of which

* Comptes Rendus, xciii. (1881) pp. 160–1.

† Arch. Zool. Expér. et Gén., x. (1882) pp. 101–20 (1 pl.).

only two species have yet been described; one was (1858) found by Bruzelius in *Pennatula rubra*, the other by Claparède in *Lobularia digitata*. The species now studied was found to change its form incessantly during life, so that at one time it was cylindrical, and at another rounded, and it might just as well as Claparède's species have received the specific name of *proteus*; a kind of soft parenchyma, charged with globules, which are probably fatty in nature and are coloured red, fills the body and renders it almost opaque. The delicate chitinous membrane which envelopes the body presents no trace of permanent annulation, but only temporary constrictions, which correspond to any given state of contraction of the body. Of the details of structure we can only say that, so far as the nervous system is concerned, all that the author could discover was a small refractive thickening near the eye, to which he is in doubt whether or not he should apply the term of ganglion; the eye, itself, is unpaired though double, and is to be found on the dorsal side a little behind the rostrum. The nauplius-form was detected and some of its characters were made out.

This third species has been named *Lamippe duthiersii*. As to its exact systematic position there would seem to be some not inconsiderable doubt, but it certainly is Crustacean, and, owing to the polymorphism exhibited by the parasitic Copepoda, we may for the present regard the Lamippidæ as forming a special division of that group.

The next subject discussed by Joliet is that of the functions of the dorsal feet in the Notoproctous Crustacea. It is a well-known fact that the *Dromiæ*, especially when young, hide themselves under a kind of carapace, formed by a sponge or an alcyonium which they hold on their back by the aid of their hinder feet, and he has observed and here enters into full details with regard to the habits of these Crustaceans; he finds also that the Dorippidæ do the same thing, and, though there is some difference in the anatomical structure of these two sets of forms, there is no doubt that they have the same habit of hiding themselves under various objects either to protect themselves against their enemies, or to hide themselves from their prey.

Pontonia diazona n. sp., presents an instance of mimicry. The Ascidian genus *Diazona* is very common at Mentone; having placed a small quantity of the masses formed by these creatures in clean water, the author was, shortly afterwards, surprised to see a small Crustacean swimming freely about. From a distance the animal could only be detected by the movements that it made in the water, so completely transparent was it. Left to itself, it soon re-established itself on the *Diazona*, where the transparent parts became so completely confounded with the hyaline structures of the Ascidian, and the yellow parts agreed so completely with the yellow markings of the colony, that it was only by shaking or by previous knowledge that its existence could be detected. It was not possible to discover whether it was a true parasite, or only a commensal, but its coloration and its habits are sufficiently striking examples of mimetic action to justify

attention being drawn to it. A technical account is given of the specific characters, but the author was unfortunately unable to draw the creature while it was fresh; the characteristic coloration dis-disappears after preservation in alcohol.

North American Crustacea.*—S. I. Smith has some notes on the zoea-forms of *Pinnixa*, distinguishing a long-spined and a short-spined series, and he describes the characters of the adult *P. chætopterana*, and *P. sayana*. He directs attention to the occasional occurrence of tropical and sub-tropical species of Decapod Crustacea on the coast of New England, and summarizes the information that has been collected regarding these forms.

In giving an account of some genera of Amphipods, he says that in several forms the excrement enters largely into the formation of the tube. A species that was placed in a small trough with algæ pulled towards each other a few slender branches of the alga; these were fastened by threads of "cement spun from branch to branch by the first and second pairs of peræopods." When the tube had nearly attained its complete form it was still usually nothing but a transparent network of cement threads with here and there a small piece of alga. Soon after this the animal began to work into it pellets of excrement and bits of alga; the former seized by the more anterior appendages were broken into minute fragments and worked through the web. This went on till the whole animal was protected from view; the process of construction would seem to take about half an hour. All the tubes are black externally, thin, and cylindrical; within they are lined by the cement; they do not seem ever to be attached, but to be carried about by the animal.

New Copepoda.†—S. A. Forbes records new genera and new species of Copepoda from Lake Michigan and pools in Illinois. *Osphranticum* nov. gen. is similar to *Diaptomus* in general appearance, but differs especially in the structure of the fifth pair of legs of male and female. *O. labronectum* is the single species. *Epischura* nov. gen., in the general character of the legs both natatory and clasping, stands near *Heterocope* of Sars, but is remarkably distinguished from all other Copepoda by the development of the abdomen of the male as a prehensile organ, the second and third of the five segments are produced on the right side as large and strong processes which act against each other like forceps, while a toothed plate on the fourth segment and a spatulate one on the fifth assist to form a peculiar and powerful grasping apparatus. "A steel trap attachment to the tail of an alligator would," the author says, "very well illustrate the vigorous embrace of the animal" (*E. lacustris* nov. sp.). In addition, three new species of *Diaptomus* (*D. sicilis*, *D. leptopus*, and *D. stagnalis*), and two new species of *Cyclops* (*C. thomasi* and *C. insectus*) are described.

In ten "bladders" of *Utricularia vulgaris*, taken at random, 93 animals, either entire or in recognizable fragments, were found, repre-

* Trans. Conn. Acad., iv. (1882) pp. 243–84 (1 pl.).
† Amer. Natural., xvi. (1882) pp. 537–42, 640–9 (2 pls.).

senting at least 28 species. Seventy-six were Entomostraca of 20 species. Nearly three-fourths were Cladocera. One-third were *Acroperus leucocephalus* Koch.

Vermes.

Development of Annelids.* — Professor W. Salensky gives an account of his own observations; in dealing with marine forms, he studied among others a species of *Terebella*, *Nereis cultrifera*, and *Spio fuliginosus*. In all that he studied he found cleavage to be unequal, and to lead to the formation of an amphigastrula; before the division on the surface of the egg lively protoplasmic movements were always observed in *Spio*, the protoplasm giving rise to lobate, clear, pseudopodia-like processes, which altered in form during the whole process of division, and at its conclusion were withdrawn. The first rudiment of the mesoblast appeared to arise from the micromeres of the second cleavage; in some other cases the mesoderm appeared in the form of two primitive mesoblasts lying near the edge of the blastopore; in *Psygmobranchus* the primitive endodermal cells do not represent the whole endoderm, for they only form the dorsal portion of the nutrient cavity, while its ventral wall arises from a collection of cells on the ventral surface (secondary endoderm). The author finds that the mode of formation of the mid-gut is different in the forms examined by him; in *Nereis dumerilii* Goette found that the endoderm arose from the four large endodermal cells, in the form of a ventral cord of cells, while the four (and later) five large fat-containing cells were pressed forward and dorsally, and used as nutrient yolk. In this arrangement the author found *Psygmobranchus* to agree more closely than *N. cultrifera*. Differences were observed in the origin of the fore- and hind-guts, which in *Psygmobranchus* and *Aricia* had an endodermal, and in *Nereis* an ectodermal origin. Striking as this difference would appear to be, it was found to be really more quantitative than qualitative; and the endodermal origin is to be regarded as nothing more than the result of an incomplete ectodermal invagination.

Greater similarities were noted in the mode of development of the nervous system; and the results of Kleinenberg and other later investigators as to the independent origin of the supra-œsophageal ganglion and the ventral ganglionic chain were confirmed. It was noted that a cord-like process always extended from the lower surface of the frontal plate to the subjacent mesoderm; and these were regarded as being homologous with the cords which, in vermian larvæ provided with mesenchymatous cells, form the rudiments of these cells. After discussing the characters of the ventral ciliated groove, Salensky states that in not very young larvæ of *Psygmobranchus* he observed, between the epithelium of hind-gut and the "Darmfaserblatt," a cavity filled with clear fluid; the wall of the cavity was contractile and exhibited regular pulsations, by means of which the fluid was driven forwards. In *Terebella*, likewise, the formation of the blood-vessels is preceded by such a perigastric

* Biol. Centralbl., ii. (1882) pp. 198–208.

cavity, whence the enteric vessels are derived. It is important to note that in the lower Annelids (e. g. *Protodrilus leuckarti*) there is permanently some such arrangement of the blood-vascular system, while, further, we are shown that at first the blood-vessels have nothing to do with, but are completely independent of, the lymphatic spaces (cœlom, &c.).

In *Branchiobdella* the ova, like their parent, are to be found in the gill-lamellæ of the crayfish; they are of some size and are covered by a hard shell, produced posteriorly into a small stalk of attachment. There is very early a difference between the appearance of the dorsal and ventral surface, and cleavage obtains much more rapidly among the cells of the latter. The endoderm and mesoderm are formed by the division of the macromeres, which constantly extends from behind forwards; no primitive mesoblasts were detected. Soon after the formation of the layers a small depression appears on the dorsal surface, the significance of which could not be made out, though it was possibly the rudiment of the supra-œsophageal ganglion. Soon after the appearance of this depression there appears on the ventral surface a large groove—the *neural* groove; this is pyriform in shape, the broader end being posterior, and the narrower anterior end having a T-shaped enlargement. At first, the groove consists of a layer of flattened cells, which are not to be distinguished from the other ectodermal cells; they soon, however, increase in number, and the groove itself is thereby narrowed and flattened out, till it becomes converted into a tube—the *neural* tube. About this time, the hinder portion of the embryo also becomes altered; the cells which were arranged in two rows divide, and the hinder part gives rise to two median ridges, which correspond to the germ-stripes of other Hirudinea. Segmentation commences early, and, after it has commenced, the embryo undergoes a series of changes, in consequence of which the dorsal surface ceases to be, and the ventral becomes convex. Prior to the formation, which is somewhat late, of the cœlom there is a cavity on the dorsal surface between the ecto- and endoderm; this is generally anterior in position, and may be spoken of as the primary cœlom. The oral invagination of the ectoderm gives rise to nothing but the inner lining of the lips, all the other parts of the mouth and its region being endodermal in origin.

Development of the Central Nervous System of Annelids.*—It is pointed out by J. W. Spengel, in an account of Kleinenberg's recent researches on this subject, that we have here to do with the development of new structures in the course of phylogenetic development. The special larva studied appears to have been *Lopadorhynchus*, which is of the Lovenian type. Simple as are most of the organs of this form, the ectoderm presents considerable histological differentiation; a strong nerve lies in the groove formed on the ciliated girdle, and this nerve is circular. On the upper hemisphere of the larva the ectoderm is found to consist of large elements, immediately below

* Biol. Centralbl., ii. (1882) pp. 231–6.

which we find a small but deep pit in the ventral middle line. The cells around the pit are small and spindle-shaped, or are large and branched, and call to mind isolated ganglion-cells. The latter do not touch the surface, but are completely shut off from it by other ectodermal cells. All these form the first rudiment of the preoral nervous apparatus of the larva. On the lower hemisphere of the larva part of the ectoderm is, again, composed of as large cells as some of those in the upper hemisphere, and these are found in a ventral triangular area, the apex of which is turned towards the anus. This area is divided by a groove into two symmetrical lateral halves. On either side there is a thickened ectodermal band, the so-called ventral germ-band. From this there is gradually separated off a lower layer which forms the definitive mesoderm, while of the remainder the median portion gives rise to the ventral nerve-cords. Before these series of differentiations have been completed the ganglion-cells of the upper hemisphere have, by means of their processes, become connected with one another, and have thus given rise to a kind of plexus. Some, however, of the small spindle-shaped cells have by their processes become closely fused with the fibres of the nerve-ring, and a transverse commissure has been developed by the anastomoses of the cells on either side of the hemisphere. We have now, therefore, got a semicircular loop which extends over the ventral surface of the upper hemisphere, and passes by its ends into the nerve-ring. Just about this time a connection is also established between the nerve-cords in the lower hemisphere and the circular nerves. As this takes place at the point of formation of the anterior commissure, we find that the rudiments of the cephalic ganglion and of the ventral ganglionic chain are at first connected with one another by the intermediation of the circular nerves.

Kleinenberg compares this nerve-ring in the polychætous larvæ with the nerve-ring of the medusæ, and speaks of the upper hemisphere of the worm-larva as the umbrella, and the lower as the subumbrella. But if the nerve-ring is the nervous system of the larva, then it has no homologue in the developed worm. "We see, therefore, in the cycle of the ontogenetic development of one animal an organ of the same physiological significance appearing twice over, and as being formed on two different types. The larvæ of Annelids possess the old nervous system of the Cœlenterata, while the Annelids themselves have their own proper central organs, which are in no way modifications of the other. The organ of the lower type is developed, and is functional in the larva, but in the adult it is replaced by a fresh formation."

In explanation of this remarkable modification, Kleinenberg points out that variations have a definite character, which, though dependent on external activities, must also be conditioned by the characters of the form itself. The mere development of any new organ must be accompanied by changes within, though perhaps not without, the organism. There is a limit, as it were, of equilibrium to variations, but this limit may be passed if the change is of advantage, and then we find considerable modifications in the organism itself. The

development of a nervous organ must result in a rearrangement of all the organs of the body, and may affect indifferent tissues. When this happens new structures arise, which will owe the direction they take to the organ that has caused them, which probably will itself become larger and more complete. The formation of a central nervous organ will cause a change not only in the already developed peripheral nervous system, but in a number of indifferent ectodermal cells, which will take on a nervous character and become united into new organs. This process may be called that of substitution, and is not to be confounded with change of function, or with the process of the physiological division of labour.

Applying these considerations to the Annelids, and starting from the Cœlenterata, we find in the Annelid larva a nerve-ring and a sensory epithelium. The organs of the latter gradually took on the functions of the old nerve-ring, and became converted into more independent organs. As the function of the primitive central organ disappeared it became suppressed, and is only seen now in the organization of the larva. The notochord and vertebral column of the vertebrata probably afford another example of this process of substitution.

Coral-reef Annelid.*—The Rev. T. Powell gives an account of the structure and habits of *Palolo viridis*, in which he states his reasons for considering as inaccurate the notion that the animals break up into small pieces in order to effect the liberation of the eggs and of the sperm. Their sight is evidently perfect. The time of their appearance is the day of the last quarter of the moon in each October, unless that fall at the beginning of the month, in which case another lunar month will intervene. This indicates that the moon exercises some mysterious influence on their reproduction.

Muscular Tissue of the Leech.†—T. W. Shore finds that—1. The muscle of the leech consists of elongated tubes with two coats—a sarcolemma and contractile layer—the inner surface of which is irregular, and gives rise to apparently granular contents. 2. In the living condition it is unstriped. 3. There are no nuclei. 4. Transverse striation may be produced post-mortem, the result of three changes:—α. Regular arrangement of the papillæ on the inner surface of the contractile layer. β. Folding of the surface of the sarcolemma. δ. Splitting into segments of the contractile substances which subsequently contract. 5. The contractile substance coagulates, forming myosin, which subsequently contracts. 6. The rapidity of contraction gives rise to varying appearances of fissures, striations, &c.

Observations on the Dicyemidæ.‡—E. van Beneden gives us the result of some further studies on these important forms. He commences by describing two new generic types, the first of which, *Conocyema polymorpha*, lives with *Dicyema typus* in the renal cavity of *Sepia officinalis*. It is not, however, nearly so common as its com-

* Journ. Linn. Soc. (Zool.) xvi. (1882) pp. 393–6.
† 'Nature,' xxvi. (1882) pp. 493-4.
‡ Arch. de Biol., iii. (1882) pp. 195–228 (2 pls.).

panion, but here, as elsewhere, two kinds of females can be distinguished—the nematogenous and the rhombogenous. The former have a body of very variable external appearance; it may be elongated, irregularly rounded, claviform, much swollen at one extremity, or attenuated at both. Four granular lobes can always be distinguished, and these, although they vary much in form in different individuals, are always formed of a single cell, just as are the two lobes in *Dicyema*. As in other Dicyemidæ, there is a cortical layer and an axial or medullary body. The former is made up of a small number of epithelial cells, set in a single layer, and so touching one another as to form a continuous membrane, which completely shuts in the medullary portion. Each cell is ciliated in youth, and smooth when adult. It is not possible, as in *Dicyema*, to distinguish polar and parapolar cells, there being no cephalic tuft. As may be supposed, the medullary body consists of a single cell. In this there are to be found germs and embryos at every stage in development. It varies greatly in form, but is always limited by a firm layer of protoplasm, of equal thickness throughout its whole extent, and always capable of allowing of the passage of the contained embryos. The nucleus is generally oval, has a distinct limiting membrane, and is traversed by a nucleoplasmatic reticulum.

When the embryo is on the point of leaving its parent it presents a convex and almost hemispherical hinder face. It is about one and a half times as long as it is wide, and a short way from the anterior end there is a circular constriction which has sometimes the appearance of a rather deep groove. It is covered by vibratile cilia, by the aid of which it swims freely in the liquid of the *corpus spongiosum*, when it has made its way out of its parent, and in thus moving it describes a spiral. The cuneiform embryo of *Conocyema*, like the vermiform one of *Dicyema*, has a large central cell, and a peripheral epithelial investment; but while in the latter it is always fusiform or cylindrical, it is here always spherical. Among the outer cells the four apical ones may always be distinguished. The embryos, with these characters, are all developed from monocellular germs, which have all the signs of true ovules. These divide into two, and then into four blastomeres, one of which is often very much larger than the rest. In the next stage there are six small and one large cell, and then we have an epibolic gastrula. The six smaller outer cells dividing, we get thirteen in all, which is the number characteristic of the adult. The cuneiform embryo escapes to the exterior by perforating the body of its mother, the four apical cells become charged with granules, the axial cell becomes enormously developed, and new germs appear.

After pointing out briefly the characters of the rhombogenous form, Professor van Beneden passes to *Microcyema vespa*, the small embryo of which was taken by G. Wagener for the infusoriform embryo of *Dicyema gracile*. It is divided into two parts by a median constriction; the hinder of these consists of an axial fusiform cell, and of two others which completely envelope it. The anterior end of the central cell projects into the anterior segment, where there is also a granular mass and a cortical layer, formed of two clear cells similar to those

which are found in the hinder segment. The parent is tubular in form, slightly enlarged at one end, completely smooth, with a delicate cortical layer. Transitional forms between these two stages were observed, and it was found that the anterior tuft of cilia on the embryo disappears very early. The author thinks himself justified in regarding this form as a distinct generic type.

As has been pointed out by Huxley, we cannot form any definite opinion as to the affinities of these forms until we know something more about the characters of the infusoriform embryo; Van Beneden believed that this form might be the means by which the parasite passed from one to another individual Cephalopod, but the researches of Metschnikof and Julin on the history of the Orthonectida have largely destroyed that hypothesis, and now give rise to the question whether the infusoriform type is not the mature male, and its "urne" a testicle; to see if this view could be confirmed the author closely examined them in the hope of detecting spermatozoa, but in vain. On the other hand, we now know that the spermatozoa of the Orthonectida are very small and very difficult to see. Too much weight must not, therefore, be given to this negative result. And the hypothesis which suggested the investigation commends itself, on many considerations, to the author's mind.

When the first studies on the Dicyemidæ were published, the absence of any mesoderm was insisted on; since that time, and chiefly, thanks to the researches of the brothers Hertwig, it has been allowed that the mesodermal formations in the Metazoa have not all the same anatomical value. Still, it remains true that the Dicyemidæ have neither mesenchyma nor cœlomic folds. This being so, we find in this important fact a justification for the establishment of a phylum of *Mesozoa*. These may be defined as "organisms formed of two layers, the ectoderm of a layer of more or less ciliated cells, the endoderm of a single or of several cells. The sexual products arise from the endoderm. There is no mesenchyma, cœlomic folds, or any fundamental lamella; two female forms, one arising exclusively from the males, the other from the females. All the Mesozoa actually known are parasites." They are divisible into the Orthonectida and the Rhombozoa; the former have the body composed of several rings and the endoderm of several cells, some of which take on the epithelio-muscular type, and give rise to muscular fibrils, while the others form the sexual products. The male is elongated, and the female oviparous. The Rhombozoa, which are divisible into the Dicyemida and Heterocyemida, have the body annelated, the endoderm formed of a single cell, no muscular fibrils. The male is peg-top in shape, refractive bodies are found in some of the smooth anterior cells, and the females are viviparous.

The author discusses the question as to whether the Mesozoa are Metazoa degenerated by parasitism, and specially the doctrine of Leuckart,* that they are comparable to the ciliated larvæ of the Distomata. He points out that the resemblance is chiefly external, and that a *Dicyema* is much more like a *Planula* or a *Gastrula*, and

* See this Journal, *ante* p. 343.

that, further, the ectoderm never gives any indication of the development of an intermediate layer. In examining the question of the homology of the medullary body of *Rhopalura* or *Dicyema* with the endoderm of a Metazoon, it is shown that in their earlier stages of development all the forms agree closely with one another, and if we allow that the inner layer (endoderm) is homologous throughout the whole of the Metazoic series, we can find no good reason for shutting out the endoderm of the Mesozoa. Certainly no supporting fact is to be found in the absence of a digestive cavity, as the Acœla, among the Rhabdocœla, with their intracellular mode of digestion, are alone sufficient to demonstrate.

Orthonectida.*—C. Julin here gives a full account of his researches, to the preliminary notice of which we have already referred (p. 511); he is of opinion that the Orthonectida cannot be considered as triploblastic forms or Metazoa, but as Mesozoa or diploblastic forms, the muscular layer which is developed not being a formation of a mesoderm, but only a histological differentiation of the endodermic cell; so far they resemble the Actinozoa, but they are distinguished from them by the fact that the muscular cells do not, throughout the whole of their life, remain connected with the endoderm. When we compare them with the Dicyemidæ we find various points of resemblance, (1) Just as in them there are nematogenous and rhombogenous forms, so in these there is a flattened form which gives rise only to female embryos, and a cylindrical form whence develope the males, and the two female forms are to be found in the same host; (2) the gastrula in both groups is formed by epiboly; (3) the structure is essentially the same in the two—a ciliated ectoderm, differentiated into a cephalic region at the anterior pole, and an endoderm of one or of several cells; the difference in this last character is due to the different mode of formation of the germs; in the Orthonectida they arise by division of the primitive endodermic cell, and in the Dicyemida by an endogenous process. The views of Giard and Metschnikof that the Orthonectida may be compared to the Turbellaria, are objected to chiefly on the ground of the great development of the mesenchyma in these lowly worms; the doctrine that they have degenerated under the influence of the parasitic habit is not confirmed by the history of their development, in which they exhibit no traces of any higher organization.

Julin regards the Mesozoa as pluricellular organisms, composed of two kind of cells, ectodermal and endodermal, without any trace of any mesenchyma, cœlom, vessels, muscles or nervous tissue of mesodermic origin; they are developed by the division of the egg-cell and its differentiation into a peripheral and a central layer. He insists on the incorrectness of the use of the term metamere or segment as applied to these forms, pointing out that the appearance which has induced some authors to apply these expressions is due only to the presence at certain points of shallow grooves between the transverse rows of ectodermic cells, there is no internal segmentation corre-

* Arch. de Biol., iii. (1882) pp. 1–54 (3 pls.).

sponding to this appearance, and in some cases a large number of females may be seen to be without it altogether. A more proper term would be "ring" simply.

It is not easy to detect when an Ophiurid is infested by these parasites, but as a rule such specimens have a more greyish tint, their tissues appear softer, and their movements are less rapid; as a rule one in twenty *Amphiuræ* were found to contain Orthonectids; the observation of Metschnikof that a consequence of their presence is an atrophy of the genital glands, has been verified by Julin.

An adult male is 0·104 mm. long, the body fusiform and elongated, and a little drawn out at either end, there are generally six rings, the cilia on the first (head) are directed forwards, and on the rest backwards; the spermatozoids are contained in a structureless pouch, and when mature may be seen moving about rapidly within it; when the wall of the pouch bursts they escape between the muscular fibrils, which separate from one another so as to form a cavity, bounded externally by the ectoderm; the cells of this layer undergo change and some become detached, and the male products are then able to make their way to the exterior; at the same time it may be seen that the muscular fibrils undergo atrophy.

The cylindrical form of the female is 0·280 mm. long, is fusiform and has generally eight rings, the first and last of which are formed by a large number of small ectodermic cells. The flattened form of female is 0·250 mm. long, has wide ventral and dorsal surfaces, and narrower sides, the grooves are so shallow that it is impossible to count the number of the rings, and the whole surface is covered with cilia; this form was regarded by Metschnikof as being immature, but the presence of ova is not in support of that view, which is more completely contradicted by the differences between its history and that of the cylindrical form; the flattened forms appear to break up into fragments, and the ova, instead of being free, are kept united together to form more or less regular masses, limited externally by a ciliated epithelial layer derived from the ectoderm of the adult. As has been already stated, there is a difference of sex in the products of these two female forms. As to the question of parthenogenesis, which is raised by some observations, the author does not yet feel himself able to speak confidently.

New Rotifer (Cupelopagis bucinedax).*—Mr. S. A. Forbes describes a new Rotifer as follows:—

Cupelopagis gen. nov. Footless, eyeless, without carapace, and totally destitute of cilia or other vibratile structures, or locomotor organs of any kind. The trochal disk has the form of a large, oblique cup, which can be either retracted wholly, or pushed up by a constriction of its wide mouth. In the bottom of this cup is the oral aperture, which opens into a very large, loose crop, at the bottom of which, and usually behind the middle of the body, is the mastax. The jaws, which project into the crop, are composed of two sharp, slender hooks, with about four slender, straight teeth at the inner base.

* Amer. Mon. Micr. Journ., iii. (1882) pp. 102–3 (1 fig.).

The stomach is large, and the intestine very small and short, opening on the ventral surface of the body near the posterior end.

C. bucinedax sp. nov. The body is a coriaceous, flattened sac, minutely roughened over the whole surface, nearly as broad as long, and about three-fourths as thick. The dorsal outline is longest and strongly convex, the ventral being usually somewhat concave. The cup is oblique, the ventral height being a little more than half the dorsal. Its lower wall usually presents a shallow, longitudinal cavity, so that the aperture is slightly kidney-shaped. The surface of the cup is more delicately roughened than the body, and its edge is minutely erose. In the average specimen the length of the body, without the cup, was 0·016 inch, and its width 0·014 inch.

This rotifer has no means of attracting its prey or bringing it within reach, but depends wholly on such animals as chance to swim into its oral cup. When a *Stentor* or other animalcule of considerable size enters the trap, the rotifer quickly pushes up the aperture and contracts the walls of the cup upon it, until it is forced, with a sudden slip, into the ample cavity of the pharynx. This apparatus enables it to secure much larger prey than the usual ciliated structure; but, in the absence of locomotor organs, it can only live in water swarming with suitable food. In the aquarium in which it was found it was living almost wholly on the large Stentors.

The author adds * as the result of a communication from Dr. J. Leidy, that *Dictyophora vorax* described by him,† is evidently closely allied and probably belongs to the same genus. The name is, however, preoccupied.

Echinodermata.

Anatomy of Echinoids.‡—R. Koehler finds that the Polian vesicle of regular Echinoids has the structure of an excretory organ; he describes them as being, to the naked eye, of a light brown colour, which is due to the presence of small brown lines which pass from the middle line to the periphery of the organ, becoming wider as they do so. The two layers of connective tissue, which form the walls of the organ, are so united that the space between them consists of small cavities, filled with special elements; these last are cells with a very distinct nucleus, and their protoplasm gives off fine prolongations, which extend from one cell to another. In addition, there are numerous granulations, arranged in masses and cubical cells, the nature of which could not be made out. On the whole, there is much resemblance to the excretory organ of *Spatangus*.

The author describes the pedicellariæ of *Dorocidaris papillata*, and directs especial attention to the presence of the small gemmiform ones on the buccal membrane, where they have never yet been recorded. "Five very curious appendages" are described in connection with the lantern of Aristotle, which are no doubt the gill-

* Amer. Mon. Micr. Journ., iii. (1882) p. 151.
† Proc. Acad. Nat. Sci. Philad., ix. p. 204.
‡ Comptes Rendus, xciv. (1882) pp. 1260–2.

like organs of C. Stewart. Of the four kinds of pedicellariæ in *Schizaster canaliferus* one is tetradactyle; in this form there are only two pairs of genital glands, and the sand canal does not follow its usual complicated course. In *Brissopsis lyrifera* the author notes a narrow canal which he looks upon as being a second "siphon," and, in conclusion, he states that while his observations have led him to see only slight modifications in the details of the anatomical structure and arrangements of the internal organs of regular Echinoids, he finds that in the irregular forms the internal organs have, in their differentiation, followed the migrations of the branches, which commenced in the Jurassic period and appear to have profoundly affected their primitive structure.

Anatomy of Spatangus purpureus.*—R. Koehler has studied the circulatory system of this Echinoid. He finds that the branch described by Hoffmann, connecting the intestinal vessel with the perioral ring, bifurcates at the level of the mouth, and sends one branch to the blood-vascular ring and the other to the ambulacral ring. The sand-canal is double between the mouth and the end of the œsophagus; it remains single from this point up to the second curvature of the alimentary canal, and after this is divided by septa into several secondary chambers, up to the point where it opens into the "heart"; on the opposite side of that organ it becomes a narrow tube. The so-called heart is spongy, and its cavity is in direct connection with that of the sand-canal; it consists of connective tissue, provided with numerous nuclei and cellular elements resembling those of the blood; the membrane which attaches the sand-canal to the madreporic tubercle has a similar structure, and perhaps both organs are glandular, and discharge either excretory or blood-vascular functions. The blood-vessels of the alimentary canal are derived from the external and internal marginal trunks, but the œsophagus, the 3rd curvature, and the rectum, are quite devoid of vessels. Most of those on the 2nd curvature occur on its dorsal surface, the only ventral vessels in this region being found near the orifice and on each side of the diverticulum. The intestinal vessel of Hoffmann does not reach the stomach. The vessels of the latter consist of a very close plexus formed around the opening of the diverticulum by the two marginal vessels and of vessels derived from this plexus, and extending along each side of the stomach as far as the siphon and connected by transverse tubes both on the anterior and posterior sides. The right-hand branch sends twigs to the mesentery between the diverticulum and alimentary canal. All these branches re-unite into a trunk which follows the course of the diverticulum up to the heart.

Over the vascular parts of the digestive canal the epithelium is thicker and composed of larger and longer cells than the non-vascular parts. This epithelium is made up of several layers of cells, the deepest being rounded, small, closely appressed, the superficial ones very long, 10 or 15 diameters in length; below it is a delicate continuous elastic membrane. The connective tissue behind the membrane forms

* Comptes Rendus, xciii. (1881) pp. 651–3; xciv., pp. 139–41.

two distinct lamellæ; the outer is dense, of equal thickness throughout, and remarkably refringent; reagents bring out in it the appearance of fine undulating fibrils; the inner layer is loose, with wide fenestræ, and contains numerous cells and brown or yellow pigment-granules; it is in the latter layer that the blood-vessels ramify; in the non-vascular parts it is thicker, except on the rectum. The alimentary canal is provided with glands of two different types, viz.:—(1) Mucus-cells; large, oval, very numerous, placed among the epithelial cells; they occur in the second curvature, especially at its vascular parts. (2) Glands proper; they are pyriform and multicellular, the component cells radiating from the centre of the gland; each gland opens separately into the intestine, and lies in the loose inner layer of the connective tissue, but only in the region between the first opening of the siphon and the end of the œsophagus. The nerve-ring surrounding the mouth is quite distinct from the blood-vessels, and is not embraced, as has been stated, by one of the latter. A further examination of the "heart" confirms the view of its glandular nature; it is broken up by trabeculæ into a number of cavities, containing cellular elements of two kinds, viz. either regular cells with distinct outline and tolerably refringent protoplasm, or cells with very irregular and indistinct outlines, with transparent but scanty protoplasm and granular nuclei, often two or three in number in the same cell; with these elements occur also brown or yellow granules, some of the yellow ones being aggregated into strawberry-like masses. Injection of the heart by way of the sand-canal shows that it communicates both with the madreporic plate and with the spaces of the connective tissue, and of the body generally; thus the blood probably undergoes some modification in the organ, and is then in part carried into the general system and in part thrown off from the body.

In *Echinocardium flavescens* the internal marginal vessel and the siphon are a little longer than in *Spatangus*, and they terminate at the point of junction between the second and third bends of the alimentary canal. This form also differs from *Spatangus* in possessing a small diverticulum or fæcal reservoir in the rectum.

Development of Asterina gibbosa.*—Professor H. Ludwig finds, as a general result of his important studies, that we have throughout the Echinodermata a mode of development which must be spoken of as a metamorphosis; the ground-form of the larva is an organism ciliated over the whole surface, with a mouth and anus on one side. By adaptation to different conditions of existence this ground-form has become variously modified as *Bipinnaria*, *Pluteus*, &c., which may be known as the secondary larval forms. The mature Echinoderm-form may arise either directly from the primary larva, or from a secondary larval form; or, further, one secondary larval may be followed by another larval form (e. g. *Bipinnaria*, *Brachiolaria*); but this interpolation of intermediate stages makes no essential difference in the course of the development. The processes by which the

* Zeitschr. f. wiss. Zool., xxxvii. (1882) pp. 1–98 (8 pls.).

primary larva is converted into the Echinoderm appear to be essentially the same in all cases; all that happens in a more complicated history being the fact that in the secondary larvæ there is an absorption of those larval parts which had themselves become secondary. The secondary characters are not to be regarded as having anything to do with the future organization of the Echinoderm, but as adaptations, proper to the larval life, and disappearing with its cessation.

After giving a description of the mode of attachment of the eggs by the female, and the mode of fertilization, the author states that the two first cleavage spheres are almost equal in size; differences, however, soon become apparent since one divides before the other. The results of cleavage are, not a solid morula, but a blastosphere with a unilaminate wall; the gastrula is formed by invagination. The absence of a morula would appear to be a constant phenomenon among the Echinodermata, and no other mode of formation of the gastrula than that by invagination has ever yet been observed. The mesoderm would appear to be generally derived from the endoderm, the cells wandering in the fluid of the blastocœl: some share, however, is taken by the ectoderm, and it may be perhaps justifiably supposed that this mesoderm presents indications of a bilateral symmetry.

The gastrula-enteron is composed of two chief portions, a short cylindrical entrance, and a spacious vesicular terminal part; from the latter we have developed the enterocœl, the first signs of which are the appearance of an out-growing process on either side, the enterocœlic pouches. All this region is to be considered as being essentially nothing more than a vesicular enlargement of the blind end of the primitive intestine. Up to and at this time the structure of the larva is still in all points bilaterally symmetrical; but this symmetry soon begins to disappear, the enterocœlic pouches are no longer of the same size, owing to the much greater development of the left one. The external form also becomes altered, and on the fourth day there appears at the centre of the anterior side a depression of the ectoderm, which is the rudiment of the mouth and stomodæum of the larva. Towards the end of the fourth, or on the fifth day, the enterocœl becomes completely shut off from the larval enteron and the larval stomodæum opens into this latter. During the fifth day the rudiment of the water-vascular system becomes developed from the left enterocœlic pouch, and this outgrowth may be conveniently spoken of as the *hydrocœl;* connected with it are the rudiments of the five primary vessels of the water-vascular system, which first appear as five slight outgrowths. Contemporaneously with the development of the hydrocœl we have the formation of the dorsal pore of the larva, which is due to an invagination of the ectoderm, which becomes connected with the left enterocœlic pouch. With the exception of the observations of Kowalevsky on *Psolinus brevis*, the evidence of all embryologists would lead us to suppose that the history given of the hydrocœl of *Asternia* is generally true of all Echinoderms. The author is inclined to look upon the dorsal pore, in its primary relations, as being a pore which led into the

enterocœl, and that its connection with the hydrocœl, therefrom developed, is only a secondary phenomenon; this earlier relation is retained by the Crinoidea, where the primary pore opens into the enterocœl. After discussing the further development of the hydrocœl, and the history of the blood-vascular system and permanent stomodæum, the author passes to a description of the external form of the larva, where attention is directed to the so-called "larval organ," or two cephalic lobes, the one smaller and anterior, the other larger and posterior, which form a special locomotor organ and are at the height of their development from the seventh to the ninth days. The wall of this organ consists of the three layers of the body, fine muscular fibres being developed on the outer side of the endodermal layer; the cavity of the organ is a development of the enterocœl, and the whole structure may be looked upon as being the homologue of the arms of a *Brachiolaria.*

In an account of the development of the skeleton it is necessary to distinguish two groups of skeletal parts, both of which appear early; to one are due the rudiments of the ambulacral pieces of the future arms, and to the other those of the primary skeletal pieces of the dorsal side of the starfish. A detailed study of the former shows that they arise in just the same way as in Ophiurans; the latter are developed in the mesoderm of the body wall, and on the seventh day eleven pieces may be made out; one of these always has a remarkably constant relation to the dorsal pores, and is the one which becomes converted into the madreporic plate; the pore does not primitively lie in the plate, but to the left of it; this relation is of significance when compared with what is seen in other Echinoderms; in Ophiurans the pore lies towards the left margin of the plate, and in Crinoids the primary pore has a similar relation to one of the oral plates. The other ten pieces do not all arise together, or exhibit the same rate of growth; five of them are the rudiments of the so-called "radialia," or better, "terminalia" of the arms of the starfish; within and alternating with them lie the primary interradial plates, one of which forms the madreporite; the eleventh piece occupies a more central position and is the rudiment of the central plate of the back.

As the larva derived from the gastrula gradually passes into the young sea-star, the larval organs become lost, the "larval organ" and the stomodæum of the larva being the last to be retained. On the ninth day, however, the larval organ decreases in size, till on the tenth or eleventh it forms nothing but a short stalked and knobbed process. This is doubtless the peculiar peduncle noted by Desor in a species of *Echinaster*, and corresponds to the different structures to which L. Agassiz, Wyv. Thomson, and Philippi have directed attention. After describing the history of the enteric tract, and especially the mouth, the author raises the question of whether there is a plane of symmetry in the young corresponding to the median plane of the larva; he thinks that none is to be, or indeed can be, detected; want of symmetry is one of the leading characters in Echinoderm structure; yet this asymmetry is ordered by definite laws. If any radius or interradius is to be regarded as the "anterior" one, it must be that

interradius in which is placed the remnant of the larval organ, and is at the same time the anal interradius; when the larval organ and arms are both lost it may still be recognized by the fact that the madreporite lies just to the left of it, in a dorsal view.

Attention is next directed to the nervous system, which had originally the form of an annular ridge encircling the point at which the mouth is afterwards developed; the epithelium above the radial water-vessels thickens, and the radial nerves are developed from its lower layers; the rudiments are developed in an adoral and aboral direction, but before they reach the tentacles they swell out to form the eyes.

Ludwig looks upon the ambulacral plates of Echinoids as being homologous with the adambulacral plates of the Asterid and the lateral plates of the arms of the Ophiurid; the primary interradials are homologous with the genital plates of Echinoids, and the five pairs of plates which are found on the actual edge of the interradials of the starfish correspond in position to the paired interambulacral plates of Echinoids, and so represent a first pair of interambulacral plates; the so-called odontophore which the author previously took to be an intermediate piece, is now regarded as an unpaired interambulacral plate.

In conclusion attention is directed to the corm-theory of Echinoderm structure which has been revived and pressed by Professor Haeckel, the author considering that no support for it is to be found in the developmental history of any Echinoderm.

Brisinga.*—Professor E. Perrier has some notes on this interesting starfish, based on a study of sixteen well-preserved disks, two young, and a large number of perfect, though single arms, in addition to a magnificent specimen which was almost complete. Such a series has, first of all, led him to the view that *B. coronata* and *B. endecacnemos* are only two forms of the same species; on the other hand, a new form, *B. edwardsii* has been dredged in the Atlantic; in this the arms are covered by imbricated plates, without spines. It is pointed out that in *Hymenodiscus* the whole skeleton is reduced to the ambulacral and adambulacral pieces, which, therefore, must alone be regarded as the essential parts of an Asterid. In *Brisinga* we have in addition, parts of the dorsal skeleton, which are arranged in arches, more or less closely set; these are, however, only found in the swollen part of the arms, where the genital glands are developed, and they are not to be seen in the young where the glands are still rudimentary; this set of plates must, therefore, throughout the whole Asterid series, be looked on as an apparatus specially applied to the purpose of protecting the reproductive glands. The disk of *Brisinga* is formed early in life, around a digestive sac, the prolongations of which are only developed later on; these different facts appear to support the doctrine the author has already taught, that the Echinoderm, like the Medusa or the Coral, is the result of the fusion of reproductive individuals around a central nutritive one.

* Comptes Rendus, xciv. (1882) pp. 61–3.

In the young the disk consists of one central and nine large contiguous triangular pieces, some of which are interbrachial, and all of which carry large mobile spines, together with a few smaller plates, which alternate with these latter and are intermediate between them and the central piece, but considerable changes occur during growth; the central pieces become separated, the interbrachials are pushed to the edge of the disk, and, becoming placed exactly in the angle of the arms, they end by forming the odontophores. The madreporic plate is always formed on one of the plates of the first row of the disk; in *Brisinga* the forcing out of these plates stops when they reach the outer edge of the buccal ring; if the process of growth had only continued and carried all these pieces on to the ventral surface, we should have had an Asterid with the ventral surface of an Ophiurid. Here then we see a considerable "rapprochement" between Ophiurids and Asterids, while the earlier arrangement of the plates of the disk seems to M. Perrier to recall the constitution of a Crinoid.

Anatomy of Holothurians.*—E. Jourdan describes the testicular tube as being formed of three layers; an external cellular investment, a fibro-muscular zone, and a layer of internal epithelium. In *Holothuria tubulosa* the majority of the cells of the first of these are large and flattened; some, however, are distinguished by consisting of a mass of refractive corpuscles within a delicate membrane; these are feebly coloured grey by osmic acid, and are strongly coloured by methyl-green; the latter fact would lead one to suppose that they were young cells, while in their general appearance they are to be compared to fat-cells. In *Cucumaria* and *Phyllophorus* the cells of this layer can in no way be compared to ordinary epithelial cells; and it would seem to follow that in some genera of Holothurians the peritoneal elements have acquired a special importance, inasmuch as the normal epithelial cells have completely disappeared. In the median layer we find a connective membrane overlaid by a layer of very fine circular muscles, identical with those which are to be found in the Polian vesicle.

The study of the internal epithelial layer ought not to be separated from that of the spermatozoa; the sperm, if examined in spring or summer, is found to consist of a mass of large cells which may be regarded as spermatoblasts; the cells of these bodies are similar to those which line the walls of the testicular tubes, and are found, when isolated, to be identical with them. Cells, likewise spherical, are also to be made out in which the protoplasm appears to be condensed into a very large nucleus, while first one, and then several, homogeneous refractive corpuscles appear in the spermatoblasts; the granular protoplasm at last disappears altogether, and in the place of the original spermatoblast we have a cell containing a number of corpuscles, each of which represents a spermatozooid; these have, when developed, a spherical head and a very long tail.

It has been found that each tube of the so-called Cuvierian organ consists of a muscular sheath formed of bundles of longitudinal and a

* Comptes Rendus, xcv. (1882) pp. 252-4.

layer of circular fibres; in the centre there is a mass of folded and spiral fibres, and in the axis of each tube there is a narrow, irregular canal, lined by cells containing granular protoplasm. By the contraction of the muscular sheath the animal forces to the exterior the connective elastic mass within each tube; these become agglutinated with all the bodies with which they come into contact.

Cœlenterata.

Tissues of Siphonophora.*—C. Chun, in his second paper,† adds some facts as to the nervous system; he finds that the richly branched ganglionic cells on the upper surface of the disk are connected with one another by their terminal processes, in addition to which triangular connecting plates are developed at the points of division. Exceptionally large ganglion-cells lie on the radial muscular fibrils, and give rise to a kind of nerve-ring. Ganglion-cells are also to be found on the inner or chitin-secreting lamella of the ectoderm, but they are not so richly branched or so large; similar cells have been detected in the ectoderm of the air-sac, and the gastric polypites of *Rhizophysa*, and in the gastric polypites of *Physalia*. In these forms the ganglion-cells pass inwards, but in the ectoderm of the tentacle of *Apolemia uvaria* they remain superficial. As yet the author has failed to find nervous cells in the transversely striated musculature of the nectocalyces of *Diphyes*, where they might naturally be looked for; at the same time it was found on experiment that stimulation of one nectocalyx is carried over the whole colony.

Ciliated and glandular cells are widely developed in the ectoderm; the tentacular appendages at the base of the fishing-tentacles of *Physalia* are invested thickly by stinging-cells, among which long supporting and numerous glandular cells are to be made out. The supply of mucus in the Velellidæ may be supposed to take the place of the absent fishing lines.

The arrangement of the musculature which obtains in the Siphonophora would appear to be that which is found in most Hydroids; there are longitudinal fibres developed from the ectodermal epithelio-muscular cells, and transverse, or circular, endodermal muscular fibrils; the latter system would appear to be best developed in the air-bladder of *Physalia*, where in addition to the muscles ganglion-cells may be made out.

Structures called ciliated funnels are described as being found in the endoderm of the middle third of a tentacle of *Apolemia uvaria*; there may be seen three endodermal longitudinal ridges which can be followed almost to the tip of the tentacle; they consist of non-ciliated mucus-cells, with, on the surface, triangular ciliated cells, containing a coarsely granular protoplasm; some of these are provided with a ciliated funnel and project freely into the body-cavity. The funnel widens out at its free end, where there are a large number of large cilia which bend over the surface of the cell, and keep up a constant movement. A canal may be made out which extends into

* Zool. Anzeig., v. (1882) pp. 400–6.
† See this Journal, i. (1881) p. 468.

the base of the funnel and there ends in a certain number of vacuoles; the author has convinced himself that these remarkable structures are an integral part of the animal, but he is not able to make any generalizations with regard to them.

In the highest Siphonophora the mesoderm is represented by the widening out of the lamella, at certain points, into a well-developed gelatinous layer.

While in the lowest, the Calycophorida, an air-sac is absent, it only becomes more complicated as the organization of the Siphonophore becomes higher; in these, however, it is still lined by ectoderm, and never becomes, as Gegenbaur supposed, completely closed. Some of the cells of the ectoderm are of very large size; only one or two cells forming cæcal processes 2 mm. long; the cells themselves may be 1 or $1\frac{1}{2}$ mm. long, and their oval nuclei measure ·13–15 mm., so that they are among the very largest known in animal tissues.

Development of Tubularia cristata.* — The development of Tubularian Hydroids has been a subject of some dispute. The latest paper, that of Ciamician,† describes an irregular segmentation resulting in an epibolic gastrula. This result, so out of accord with the development of other Hydroids, has been much questioned and denied, and H. W. Conn has accordingly made a careful study of the Tubularian embryo, in the case of *T. cristata*, avoiding the sources of error in Ciamician's observations by removing the egg completely from the medusa and examining it by itself. In the result he finds that the development of *T. cristata* agrees completely with other Hydroids, the segmentation and formation of the germinal layers coinciding completely with Cœlenterates in general. *Tubularia*, which has been considered somewhat of an anomaly in Hydroid development, presents, therefore, no noteworthy difference from the rest of the Hydroids.

American Acalephæ.‡—J. W. Fewkes is adding considerably to our knowledge of these forms. In discussing the characters of the Ctenophore *Ocyroë crystallina*, the author points out that, according to the classification of Chun, in which the Ctenophora are divided into the Tentaculata and the Nuda, the form in question would be placed with the non-tentaculate *Beroë*, with which it has few other anatomical likenesses. If Chun's classification is to be followed *Ocyroë* must be regarded as a form connecting his two groups, and indeed it has, as A. Agassiz has pointed out, "structural characters of the Lobatæ, Saccatæ, and Eurystomæ."

After describing *Cassiopeia frondosa*, the author comes to *Linerges mercurius*, which appears to be very abundant in the Gulf off the Florida Keys; one of its most interesting characters appears to be the characters of the "hood" of the prominent otocyst; when this latter is looked at from above it resembles a spherical sac, in the centre of which a single otolith may be seen, seated on a short peduncle; the

* Zool. Anzeig., v. (1882) pp. 483–4.
† Zeitschr. f. wiss. Zool., xxxii.
‡ Bull. Mus. Comp. Zool. Cambridge, ix. pp. 251–310 (10 pls.).

sac is regarded as being the homologue of the hood of other Discophora. In development an unequal segmentation is to be observed, and as this segmentation takes place in the water we cannot regard the subumbral pouches as being receptacles for the developing young. During the ephyra stages the cavity of the stomach becomes differentiated into an upper and a lower story by the "growth of a continuation of the lower floor of the bell into a partition in this structure."

Stephanomia atlantica is a new species of that genus of the Siphonophora which is distinguished by the multiserial arrangement of the swimming bells; the nectocalyces are much more numerous than in *Agalma* or *Halistemma*, and allow of more varied motion on the part of the animal, and a rotation of the stem is sometimes combined with a direct forward motion. *Agalma papillosum*, *Agalmopsis fragile*, *Rhizophysa gracilis*, and *Athorybia formosa* are new species; in the last we find two different kinds of tentacular knobs hanging from one tentacle.

Halitiara is the name applied to a new genus of Hydroida; this Tubularian medusa has a tall bell with a small apical projection, four chymiferous tubes without lateral glands, four long tentacles with three small ones between each, and no otocysts. *H. formosa* n. sp. Another new genus is *Halicalyx*, *H. tenuis*; *Aglaura vitrea* n. sp., allied to and perhaps identical with the common *A. hemistoma*.

Three new genera of Hydroids resulted from the explorations of the United States Fishery Commission: *Calycopsis* (*C. typa*) is related to *Turris*, but is distinguished by the presence of sixteen instead of four radial tubes, a point in which it differs from all known Anthomedusæ; *Chromatonema* (*C. rubrum*) is a form the alliances of which are still somewhat obscure. *Halicreas* (*H. minimum*) has "eight prominent rounded projections covered with tubercles on the bell margin at the extremity of eight radially arranged ribs passing from centre to circumference of the bell. No proboscis. No tentacles." Apparently allied to the Narcomedusæ, it differs from all of them in the presence of the eight radial stripes in the bell, and the eight marginal tubercles. There is a velum which indicates that it is a true Hydroid medusa.

The author discusses the development of the chymiferous tubes in *Mnemiopsis leidyi* and points out the radical differences between it and *Bolina*, the history of which has been related by A. Agassiz.

Sense of Smell in Actiniæ.*—Mr. W. H. Pollock and Dr. G. J. Romanes have found that the common sea-anemones are conscious of the presence of any kind of food (pieces of cockle, mussel, &c.) placed near them. If the food was held within a span's breadth of an individual anemone the creature opened; if it was held in the centre of a circle of anemones they gradually opened in succession. They were found to be unable to localize the direction in which the food was lying.

Dr. Romanes considers that the sense which is thus shown to be

* Journ. Linn. Soc. (Zool.) xvi. (1882) pp. 474–6.

possessed by these animals may most properly be called a sense of smell, and they are the lowest animals in which any such sense has hitherto been noticed. It was not found practicable to determine by experiments whether the sense is restricted to any special part of the organism or is diffused over the whole.

Protozoa.

Ciliation of the Hypotrichous Infusoria.*—J. van Rees, in a preliminary paper to a larger work on the marine Infusoria, describes in considerable detail the ciliation (more especially) of *Styloplotes grandis* n. sp. A new diagnosis is given of *Euplotes longipes*, whose ciliation is compared with that of the former.

Species of Vorticellæ.—Mr. W. Saville Kent in the third vol. of his 'Manual of Infusoria' gives a plate constituting a very useful key to the numerous species of the genus *Vorticella*, each of the forty-two species being represented in diagrammatic outline at its most typical condition of extension.

Acinetidæ.†—E. Maupas has studied the forms obtained by him in Algiers and at Roscoff in Brittany, and describes at length *Sphærophrya magna*, *Podophrya limbata*, *Acineta pusilla*, *A. Jolyi*, *A. emaciata*, *A. fœtida*, *Hemophrya thouleti*, and *H. microsoma*. An important observation is recorded as to the ingestion of food by *S. magna*. When an Infusorian is caught a rupture in its cuticle is produced at the point of contact with the tentacle. According to the author the axillary substance of the latter consists of clear homogeneous sarcode continuous with that of the body of the Acinetan, and this passes into the Infusorian, and probably accelerates its death. The tentacle now increases greatly in thickness, due without doubt to the afflux of sarcode from the Acinetan, from which a current is thus established in the direction of its prey, not, however, visible in consequence of the transparency of the sarcode stream. The latter mixes freely with the contents of the victim's body, and loading itself with assimilable substances returns in the inflowing stream, which is so plainly visible by reason of the opaque granular particles held in suspension. This phenomenon is directly comparable with the sarcode circulation in the extended pseudopodia of Foraminifera or cyclosis in plant-cells, though in the former both streams are visible.‡

The author adds a full summary of the general facts which the special studies of the species have, in his opinion, established in regard to the structure and histological constitution of the *Acinetæ*, and some of the controversies which have existed on the subject.

The first question considered is whether any *naked* Acinetidæ exist, destitute of all external covering, with bodies simply composed

* Rees, J. van, 'Zur Kenntniss der Bewimperung der Hypotrichen Infusorien nach Beobachtungen an *Styloplotes grandis* n. sp. und *Euplotes longipes*.' Amsterdam, 1881, 44 pp. and 1 pl.

† Arch. de Zool. Expér. et Gén., ix. (1881) pp. 299–368 (2 pls.).

‡ Cf. for a discussion on the importance of this phenomenon Kent's 'Manual of the Infusoria,' iii. (1882) pp. 803–5.

of a mass of naked sarcode, without differentiation at the periphery into a membrane or other tegumentary layer of any kind. On the one hand, Stein and Fraipont consider all Acinetidæ without exception to be provided with an integument; whilst Cienkowski and Hertwig affirm that they have vainly sought for any integument in *Podophrya fixa*, whose body is naked. After examining the arguments of either side, the author states his own adherence to the view of the latter, what he has himself observed in *Sphærophrya magna*, still further supporting it. The periphery of this species is simply bounded by a thin cortical zone of hyaline sarcode, not distinct from the medullary sarcode, and showing none of the differentiations proper to the true membranes with double outline. The existence of Acinetidæ completely destitute of all covering membrane must, therefore be considered a well-established fact.

With regard to their *integument* the Acinetidæ being unicellular organisms, we must accept as a cell-membrane any peripheral layer with a double outline, which may exist closely applied to the surface of the body, and the author, after a long retrospective discussion of the views hitherto held (by Stein, Claparède and Lachmann, Hertwig, and Fraipont), states his own views. The Hemiophrya and Podophrya are provided with a single tegumentary covering which corresponds morphologically to a cell-membrane. The integument of *Dendrocometes*, *Dendrosoma*, *Ophryodendron*, and *Irychophrya* has the same value. The capsule, in which *Acineta* and *Solenophrya* are lodged, cannot, on the contrary, be compared to a cellular membrane, but is only a skeletal structure having no homology with the integument of the other genera. The existence of a second membrane within the shell, and applied to the surface of the body of the *Acinetæ*, has not been definitively shown in any species of this genus, and he is able positively to deny its presence in those which he has studied.

The existence among certain Acinetidæ of two sorts of *tentacles*, one destined for seizing prey, and the other for its suction, is a well-ascertained fact which requires no further support. Although differentiated in their functions, the two kinds have, however, the same morphological value, and are evidently derived from the same primitive organ. Fraipont has given excellent reasons in support of this view, and to these the author further adds the fact that in *Hemiophrya gemmipara* both kinds of tentacles penetrate into the body, whilst in *Hemiophrya microsoma*, the sucking tentacles alone have this internal prolongation. There is here a gradation in the differentiation and specialization of structure, which added to other analogous facts mentioned by Fraipont, shows that these two distinct forms are derived from one primitive form, which, in its structure and its relations with the body, must be similar to that which exists in *Podophrya* and *Sphærophrya*. Fraipont calls this primitive organ a *prehensile sucker*, wishing thus to point out its double function of absorbing and seizing.

Two very different opinions have been held as to the structure of the tentacles. On the one hand Claparède and Lachmann define them as "hollow tubes with contractile walls furnished with a sucker at

their extremity," and Zenker (in describing *Acineta ferrum-equinum*), says "The internal canal of the arms is enveloped in two layers, one internal, voluntarily contractile throughout its whole length and muscular, so to say, in its nature, the other external, inert, membranous, in continuity with the cuticular membrane of the animal." On the other hand, Stein, Hertwig, and Fraipont describe the tentacles as composed of clear homogeneous contents, enclosed in a thin membranous wall. The author thinks that both these opinions are true, and that according to the species, the tentacles may be constituted with the two structures described by these authors. In certain species (*Sphærophrya magna*, *Acineta fœtida* and *A. emaciata*), the tentacles have a direct dependence on the peripheral zone of the body; in *Hemiophrya gemmipara*, on the contrary, they are organs become completely independent of the integument, perforating the latter and burying themselves in the substance of the body. Between these two extremes we find, in *Hemiophrya microsoma*, an intermediary arrangement in which the prehensile tentacles are a direct prolongation of the tegument, whilst the sucker tentacles are formed of independent tubes, as in *H. gemmipara*. In very emaciated specimens of *Acineta fœtida*, become very transparent, the author observed a different disposition of the tentacles. The two fascicules were inserted at the extremity of a large tubular prolongation half invaginated in a deep depression of the body, and projecting a little beyond the opening of the shell.

Having examined the structure of the tentacles and their relation to the body, the author turns to the solution of the question to what organs they can be compared in the general morphology of the Protozoa. Are they *sui generis* or can any homologues be found? Koelliker, Haeckel, and Kent assimilate them purely and simply to the pseudopodia of the Rhizopoda and Radiolaria; Stein and Claus compare them to pseudopodia, but without affirming any real homology; whilst Claparède and Lachmann, Hertwig, and Fraipont consider them to be entirely different. Here, again, the author considers that in all three views there is some truth if they are limited to certain species instead of being generalized. There is a great resemblance between the tentacles and pseudopodia, both in regard to their structure and their function, but he would not, nevertheless, consider them as absolutely identical, the consequence of which would be to class the Acinetidæ with the Rhizopoda. They are organs of equal morphological value, between which there does not exist any essential difference of origin and nature and which consequently ought to be considered as homologues in spite of the particular differentiations which have managed to survive in certain types.

The author has little to say of the *nucleus*, the structure and *rôle* of which have been studied with so much skill by Hertwig, that subsequent observers, such as Bütschli and Fraipont, have only confirmed his observations. He adds, however, that the substance of the nucleus is not always as homogeneous as in *Hemiophrya gemmipara*, and that in it may be found a special histological structure, such as is seen in that of *Acineta Jolyi*, containing numerous perfectly spherical vacuoles,

each with a central corpuscle, or in that of *Acineta fœtida*, formed of a sarcodic network with irregular meshes. These two arrangements are also found, the former among ciliated Infusoria, *Climacostomum virens* and *Uroleptus piscis*, the latter in another Acinetan, *Dendrocometes paradoxus*.

As to the *nucleolus*, Stein affirms that no trace of one has ever been found, whilst Koch, Hertwig, and Bütschli do not refer to it. Fraipont alone states that he has found *within* the nucleus of *Ophryodendron belgicum*, *Acineta tuberosa*, and *A. vorticelloides*, one or more much darker corpuscles of nucleolar appearance; but Koch has studied a species of the first genus and Hertwig *A. tuberosa* without finding any nucleolus, and the observations of Fraipont are too doubtful to be accepted. The author has, however, examined *A. fœtida* and *Podophrya limbata*, and has always found a nucleolus *exterior* to the nucleus, and similar in form and size to the nucleolus of the ciliated Infusoria. The animals were killed with a 1 per cent. solution of acetic acid or by the vapours of a solution of osmic acid of similar strength, then coloured with carmine, and after being washed, cleared with pure glacial acetic acid, for which was finally substituted glycerine, leaving it to penetrate in proportion as the acid evaporated.

Our knowledge of the Acinetidæ is, in M. Maupas' view, much too incomplete to definitely establish their systematic position in the Protozoa. Too much has been made of some of their resemblances to the Ciliata, whilst the considerable and fundamental differences have been neglected. If the author were asked to what group they have the most affinity, he would reply that they have much affinity with the Heliozoa. There is a great resemblance in the disposition, structure, and the mode of action of the pseudopodia of the latter and the tentacles of the Acinetidæ. This resemblance is still more striking when we remember the manner in which *Podophrya Trold*, according to Claparède, devours its prey, the suckers enlarging enormously and swallowing their captives, making them penetrate whole into the body, instead of sucking them slowly as in the other Acinetidæ. This mode of prehension of the food much resembles that of *Actinosphærium Eichhorni*, and gives us one more link between the two kinds of organs. "Are we then to consider the Acinetans as derived from the Heliozoa? I think that would be going much too fast. . . . Between these two groups of Protozoa there exist, particularly in the phenomena of reproduction, differences too great for it to be possible to admit a direct filiation. Let us be content for the present with having indicated their points of resemblance without wishing to deduce consequences to which perhaps they do not lead."

New Type of Porcellanous Foraminifera.* — Mr. H. B. Brady describes from the 'Challenger' expedition a new genus and species (*Keramosphæra Murrayi*), which illustrates a very distinct and independent type of foraminiferal structure not previously described, though closely related to certain well-known porcellanous forms, and presenting a certain analogy to *Orbitolites*.

* Ann. and Mag. Nat. Hist., x. (1882) pp. 242–5 (1 pl.).

The test is free, porcellanous, spherical, formed of concentric layers, each consisting of a large number of chamberlets arranged more or less regularly in single series. Chamberlets of the same layer communicate with each other by short lateral stolons; those of the successive layers by the pores which formed the superficial apertures of the previous layer. Aperture consisting of numerous pores, one at the margin of each chamberlet. Colour white; surface areolated by the outlines of the somewhat convex chamberlets of the peripheral layer. Diameter about $\frac{1}{10}$ inch (2·5 mm.). The specimens were found in material dredged during the 'Challenger' expedition at a depth of 1950 fathoms, in a locality, roughly speaking, about 25° south of the south-western corner of Australia. The material brought up was a nearly white, feathery-looking, diatom-ooze, composed chiefly of Diatomaceæ, Radiolaria, sponge-spicula, and other siliceous organisms. Foraminifera were not very numerous, about seventeen species in all; and the general aspect of the Rhizopod-fauna was distinctly arctic, except that the calcareous forms were as a rule somewhat thin-shelled.

Bacterium rubescens Lank. = Monas Okenii Ehr.* — L. Olivier considers that he has established that the *Bacterium rubescens* of Prof. Lankester† is not a *Bacterium*, but is in reality *Monas Okenii* of Ehrenberg.

The organisms were found by the author in the basins of the Jardin des Plantes at Paris, to which they gave a strong red colour. They were recognized by Prof. Lankester as being *Bacterium rubescens.* They are of a cylindrical form, slightly compressed towards the middle, and slightly swollen at the extremities. The greater axis measures from 0·02 to 0·3 mm., the smaller axis 0·008 mm. The body is colourless, but contains spherical globules of an intense red. These, instead of being disseminated here and there through the protoplasm, are more often arranged in a linear series, following the greater axis. They swim very rapidly, sometimes turning spirally round the greater axis, and progressing in a rectilinear direction. There are two distinct conditions of the organism, the one characterized by the great number of the red globules, the frequent division of the body, and the rapidity of the locomotion; the other by the disappearance of the red globules and the slackening of the movements, and of the tendency to transverse segmentation. Every transition, from the first to the second of these stages, and even from the second to the first, is to be found. If we saw the elongated organisms, still active, but not in the condition of division, in a medium rich in nutritive substances, such, for instance, as broth sufficiently diluted with water, the little organisms will soon be seen to divide; and the segmentation may even be so frequent, that it sets in before the body of the animalcule has acquired one-third of the length it attains in circumstances where the segmentation is slower. The number of red globules diminishes in proportion to the activity of the organism.

* Bull. Soc. Bot. France, xxviii. (1882) pp. 216–26 (1 pl.).
† Quart. Journ. Micr. Sci., xvi.

This coincidence between the disappearance of the globule and the lessened activity leads to the belief that the globule constitutes a reserve of material for the organism.

To determine the animal or vegetable nature of the organism, the author employed various reagents. By distilled water they were slowly, and by glycerine, alcohol, and acetic acid instantaneously killed, the red colour disappearing slowly with glycerine, but rapidly in the case of the alcohol and the acid. A 1 per cent. solution of iodine is also a violent poison, causing the rapid disappearance of the pigment, and colouring the organism slightly yellow. Chloriodide of zinc acts in the same way, but the colour is a brownish yellow. Iodine and sulphuric acid used simultaneously also give a brown colour if they are not too dilute. Picric acid gives a green colour and carmine red, but if they are used successively (the carmine last), the protoplasm is coloured green and the granulations red, the centre of each remaining clear. The périphery of the body is not differentiated from the central protoplasm. Finally, an alcoholic solution of hæmatoxylin gives no colour.

After the action of these reagents no nucleus could be discovered, whatever was the stage of the life of the microbion, either in the different stages of transverse segmentation or during the increase of the body in length, a fact which deserves attention, as it affords an instance of the division of protoplasm into two individualities without it having been possible to observe any previous differentiation of its constituent parts.

There is also clearly no cellulose ternary vegetable envelope at the periphery of the body, as all the reagents which colour the protoplasm colour the external portion, and *vice versâ*. With fuchsin the colouring is general, as with carmine; it is of an equally intense red in the different regions, whether internal or peripheral. In the same way with Paris violet, it is impossible to distinguish the external membrane from the subjacent protoplasm. This membrane is, therefore, simply a protoplasmic envelope, like that of the Infusoria, and cannot be compared to the cellular membrane of the Bacteria.

The use of reagents leads us, moreover, to recognize the existence of organs very different from those which have been described among the Bacteria. In treating the organisms with a concentrated solution of Paris violet, we see at one of the two extremities, seldom at both, a filament, about 2 or $2\frac{1}{2}$ times as long as the body. It is very slender, and does not resemble the caudal prolongations which Koch has described as cilia among the *Bacilli*. It takes the same colour as the rest of the body. The existence and position of this filament leave no room for doubt, in the author's opinion, that *Bacterium rubescens* is *Monas Okenii*. Ehrenberg and Cohn's descriptions of the latter also agree in all points with that of *B. rubescens*. The filaments of *Monas* differ also from those of the Bacteria by their greater length and by the fact that they are cylindrical from their base to the free extremity.

Van Tieghem considers the caudal filaments of the Bacteria to be prolongations of the cellular membrane, and not protoplasmic cilia

endowed with spontaneous movement. M. Olivier, therefore, thought it interesting to examine whether the same was the case with *Monas Okenii*, or whether, on the contrary, their long filaments are formed in a different manner.

In a large graduated vessel 30 c.cm. of water was collected so rich in *Monas Okenii* as to be coloured red by them. One c.cm. of 1 per cent. osmic acid was added, and five minutes afterwards the vessel filled with distilled water, in order to weaken the destructive action of the acid. The next day all had fallen to the bottom, and by simple decantation an immense number could be collected in a very small bulk. Observed under the Microscope they presented different degrees of division. Those in which the segmentation was the deepest appeared to be entirely separated into two distinct masses. This is the case during life also. We then see two masses of the same shape opposed end to end, but leaving between them a transverse furrow which is quite colourless. When the *Monad* moves, these two masses move simultaneously, showing that they are united by a real though invisible tie. But if, when killed by osmic acid, they are subsequently treated with Paris violet, that which before had the appearance of a hyaline furrow—a complete interval between the two segments of the body—immediately becomes coloured in the same way as the best characterized filaments. This portion appears to be in continuity with the protoplasm, no reagent distinguishing one part from the other. As the two segments of the body become further separated, this connection grows thinner and finally breaks. Although he did not succeed in following all the phases of this phenomenon in their successive order, the author "attributes to the connection which unites the two segments of the *Monad* the same nature as to the long and slender filament previously described. Like this filament the connection is invisible without special preparation, but is easily recognized when coloured with Paris violet."

Cohn has remarked that the *Monas* in act of transverse division have a cilium at both extremities. But, in fact, one extremity is much more often destitute of any. The formation of a cilium at the free extremity of a *Monad* was never observed. The filaments, always cylindrical, are evidently flexible, for they present every imaginable appearance and position when coloured with Paris violet after being killed by osmic acid. Some experiments on dead organisms lead to the conclusion that the filaments are contractile, for on putting them into distilled water they in a few days disappeared; and this disappearance can only be explained by destruction or contraction. When the animals are fixed by osmic acid, left for some days in distilled water, and coloured by means of Paris violet, the filaments become visible; and it therefore seems that the osmic acid, by instantly killing them, prevents a contraction which would otherwise take place.

All these facts show that *Monas Okenii* does not resemble any species of *Bacterium*. Their organization, on the contrary, refers them to the nudo-flagellate Infusoria, as for example, *Spumella*. Like a great number of Infusoria (especially the *Euglenæ*), they seek the

light. The glass vessels in which they were kept were red at the side turned towards the light, whilst the opposite side remained colourless. If the vessel was blackened so that light could only penetrate through a small orifice, the *Monas* abandoned the dark regions and concentrated themselves in the light. This is not the only red organism that shows this attraction to light; and this circumstance has led to its being confounded with an Alga which has the same colour, and is deposited in the form of large pellicles on the walls of vessels exposed to daylight. *Claythrocystis roseo-persicina* is thus often found associated with *Monas Okenii.*

Oviform Psorospermiæ or Coccidia.*—A. Schneider gives the following as a provisional classification of the Psorospermiæ :—

Tribe I. The whole of the contents of the cyst are converted into a single spore. MONOSPOREÆ.

a. Spore enclosing a definite number of corpuscles. Oligozoids. Corpuscles four in number. *Orthospora.*

b. Spore enclosing an indefinite number of corpuscles. Polyzoids. *Eimeria.*

Tribe II. Contents of cyst becoming converted into a constant and definite number of spores. OLIGOSPOREÆ.

A. Only two spores. (Disporeæ.)

a. Corpuscles of the spores in definite number. *Cyclospora.*

b. Corpuscles of the spores in indefinite number. *Isospora.*

B. Four spores. (Tetrasporeæ.) Corpuscle, one. *Coccidium.*

Tribe III. Contents of cyst becoming converted into a great number of spores. POLYSPOREÆ. *Klossia, Benedenia.*

The author then describes three new genera (*Orthospora*, *Cyclospora*, and *Isospora*), with three new species, and two other new species of previously known genera.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Development of the Embryo and Embryo-sac.†—M. Treub states that *Peristylus grandis* furnishes an excellent demonstration of the fact previously recorded by him ‡ that in the Orchideæ the suspensor performs the function of a nutritive organ for the embryo. Some time after fertilization the embryo-sac is found to contain a small suspensor composed of a row of two or three cells. The upper portion of this soon grows rapidly, and finally protrudes beyond the exostome, putting out digitate much-branched protuberances, which creep over the funiculi and placentæ, robbing them of their non-nitrogenous contents for the benefit of the embryo; the cells of the

* Arch. de Zool. Expér. et Gén., ix. (1881) pp. 387–404 (1 pl.).

† Ann. du Jardin Bot. de Buitenzorg, iii. (1882) pp. 76–87 (3 pls.). See Bot. Centralbl., x. (1882) p. 356.

‡ See this Journal, iii. (1880) p. 474.

suspensor often temporarily contain starch. Immediately after receiving this supply of food-materials, the embryo, which had hitherto undergone very little change, alters in form and increases greatly in size, assuming the ordinary globular form of the embryo of Orchideæ. In *Peristylus* the embryo appears to receive the whole of its nutriment in this way, while in European orchids a portion is derived from the ovule itself.

Avicennia officinalis presents this peculiarity: that the two cells formed by division of the sister-cells of the embryo-sac are not, as is elsewhere the case, resorbed or compressed. A short time after fertilization the embryo-sac contains endosperm-cells which surround the embryo, and one large cell reaching to its apex, which the author calls the *cotyloid cell.* Subsequently the endosperm gradually emerges from the embryo-sac; the embryo undergoes in the meantime further development, and after a time is covered only on one side by a thin layer of endosperm. In this layer a cleft is formed through which the cotyledons project, while the lower end of the embryo remains in the endosperm. The upper part of the cotyloid cell, together with the endosperm, projects out of the micropyle; while its lower part, still enclosed in the ovule, puts out protuberances on all sides into its tissue and into the placenta, which, after a time, it completely permeates like a mycelium. The cotyloid cell undoubtedly performs the same function as the suspensor in orchids, viz. that of a nutritive organ, carrying to the embryo, through the endosperm, the nutritive substances contained in the ovule and in the placenta.

Embryogeny of the Leguminosæ.*—The following are the main results of an extensive series of observations made by L. Guignard on the development of the embryo and embryo-sac of a number of plants, mostly belonging to the Leguminosæ. His general conclusions do not confirm the theory of some writers that the nucellus of the embryo-sac is the homologue of a pollen-grain or spore.

The axile hypodermal cell of the nucellus divides horizontally into two cells of variable size, the apical and the subapical cells. The apical cell either remains undivided or gives rise to a tissue of varying thickness, the "calotte." This tissue is especially developed in the Mimoseæ and Cæsalpinieæ at the period of impregnation; in the latter group it remains for a time after impregnation. The subapical cell (primordial mother-cell of Warming) may either remain undivided, and develope directly into the embryo-sac (*Medicago*, *Melilotus*), or it divides into a variable number of superposed cells, the lowermost of which (the true mother-cell) displaces the others, and alone developes into the embryo-sac. Cases are described in which the number of these cells is two, three, and four respectively. The order of formation of the cell-walls is usually basipetal; they may be thicker or not than the neighbouring cell-wall. With possibly the single exception of *Acacia albida*, the embryo-sac is invariably the product of the lowermost cell, never of the fusion of two cells.

* Ann. Sci. Nat. (Bot.) xii. (1881–2) pp. 1–166 (8 pls.). Cf. this Journal, iii. (1880) p. 473; i. (1881) pp. 69, 260, 620; *ante*, p. 64.

It would appear, however, from observations made by other writers in the case of other plants (especially by M. Mellink on *Agraphis patula*) that there is a certain equivalence in the cells of the axile row, and that one or other of them may develope into the embryo-sac, but only one. Nevertheless, in some species the presence of two nuclei in the penultimate cell is nearly constant. The occurrence, or otherwise, of divisions in the subapical cell appears to depend on the greater or less rapidity of the development of the embryo-sac. This tendency to division is even continued in the embryo-sac itself, but is arrested and reduced to the remarkable division of its primary nucleus into two parts, which separate to the two extremities of the sac. The formation out of this primary nucleus of eight distinct nuclei takes place in the way described by Strasburger; but their exact position varies according to the form of the cavity. The upper nucleus divides into the oosphere, the two synergidæ, and a polar nucleus; the lower one into the three antipodals and a polar nucleus. The synergidæ are more or less closely attached to the summit of the embryo-sac; in the Mimoseæ they often attain a considerable length. The oosphere is inserted laterally, and descends below the synergidæ; its appearance varies considerably at the time of impregnation. The three antipodals are attached to the base of the sac, and are generally clothed with a thin membrane. In *Phaseolus* this is of considerable thickness; but it subsequently disappears, and the antipodals themselves have entirely vanished at the time of impregnation. In the Ranunculaceæ and Papaveraceæ, on the other hand, they survive this period. They are most developed in the Mimoseæ and Cæsalpinieæ. The fusion of the two polar nuclei takes place at different parts of the embryo-sac. It is completed before fertilization, except perhaps in the Vicieæ.

The author regards all the cells formed in the embryo-sac of Angiosperms as representing endosperm-cells analogous to those formed in the embryo-sac of Gymnosperms. The oosphere forms by itself a greatly reduced archegonium; the synergidæ are endosperm-cells adapted for a special function. The endosperm formed after fertilization by division of the secondary nucleus is the recommencement of an interrupted development.

With regard to the formation of the embryo, the first step is invariably the appearance of a transverse wall in the fertilized cell; but from this point great diversities exist, the differentiation of the subsequent product into embryo properly so called and suspensor not being constant. The entire absence of a suspensor had been noticed by Schacht, Treub, and others in a few isolated genera or species, chiefly monocotyledonous. Guignard now establishes that it occurs throughout the Mimoseæ and in some Hedysareæ.

When there is a distinct suspensor, it is differentiated at very different periods of development, according to the following six types:—

1. The suspensor may be rudimentary, and never composed of more than three or four superposed cells (*Soja*, *Amphicarpæa*, *Trifolium*).

2. It may be composed of two pairs of cells placed crosswise, the

uppermost attaining a considerable length, while the lowermost assumes a spherical form, both of these being remarkable for the constant plurality of nuclei (Vicieæ, with the exception of *Cicer arietinum*).

3. It may be formed of a filament of cells of variable number (*Ononis*).

4. It may consist of a larger or smaller number of pairs of cells, either superposed or in the same vertical plane (*Lupinus*), or in regular alternation (*Cicer arietinum*).

5. It may be composed of a greatly elongated cellular body, the cells of which are either (1) quite distinct from the embryo (*Medicago*, *Trigonella*, &c.), or (2) not completely distinct (*Galega*), or (3) much confounded with it (*Phaseolus*, &c.).

6. The cellular body may be an ovoid or rounded mass, which may differ as to the size, form, number, arrangement, and contents of the cells, and as to their relation to the embryo (*Cercis*, *Anthyllis*, *Cytisus*, &c.).

In the same genus of Leguminosæ the type remains as a rule constant, but differs within the tribe. In the Fumariaceæ we find, on the contrary, *Corydalis ochroleuca* with a much-developed suspensor, while *C. cava* is entirely destitute of one. In the order Leguminosæ we find every type that occurs in all the other natural orders.

With regard to the formation of the embryo itself, after the primary transverse segmentation which immediately follows fecundation, sometimes the lower cell is itself the mother-cell of the embryo, sometimes the mother-cell is not differentiated till after further divisions in the suspensor; the first case occurring in *Lotus*, *Tetragonobolus*, *Trifolium*, *Medicago*, *Anthyllis*, *Phaseolus*, &c., the second in *Galega* and the Vicieæ. The first division in the embryo is not, as has often been stated, invariably longitudinal; in the Vicieæ it is transverse.

The epidermis becomes differentiated on the surface of the embryo before the appearance of the cotyledons. In embryos without suspensor, as those of the Acacieæ, the internal tissues are most strongly differentiated; in the Vicieæ, on the other hand, the cotyledons are already considerably developed while the axis is still very short and shows no internal differentiation. The size of the axis, as compared to that of the cotyledons, varies greatly. In most of the Mimoseæ it is very short, and manifests, long before it has attained any considerable length, the lobes of its first compound leaves. In this tribe also the synergidæ sometimes develope into embryos, indicating that they may probably partake of the nature of oospheres.

The endosperm exists in the embryo-sac in two different states, either of free nuclei on the cell-wall, or of a parenchymatous temporary or permanent tissue; the second always succeeding the first, except in the true Vicieæ. The mode of multiplication of the endosperm-cells presents a close analogy to that of the suspensor; fragmentation is a phenomenon associated with age. The first cell-walls always make their appearance at the summit of the embryo-sac, except in *Lupinus*. The free nuclei always divide simultaneously, as also do those of the

cells. Whether the endosperm is temporary or permanent, its cell-walls are always very thin up to the time when the embryo attains its full dimensions; then either its resorption commences, or it becomes gradually transformed into a solid permanent tissue. The presence of endosperm in the mature seed must be regarded as a sign of inferior organization. Its presence is not, however, always constant in the same genus, and it cannot be considered a character of primary importance in classification.

The period of first formation of the endosperm varies considerably. In the Mimoseæ, Cæsalpinieæ, and those Papilionaceæ where there is no suspensor, or only a rudimentary one, it begins to develope when the embryo consists of only about a dozen cells; while in those cases where the suspensor is more developed it originates considerably later. The suspensor, having very often a development in inverse proportion to that of the endosperm, or being formed considerably earlier, has undoubtedly in many cases, like the latter, a function of supplying the embryo with nutrition, though in other cases it may serve no other purpose than that of fixing it.

The author considers that these embryological facts do not yet enable us to assign to the Leguminosæ their genetic position in the series of vegetable organisms.

Development of the Ovule of Primula.*—According to F. Pax, the ovules of *Primula elatior* and *officinalis* are formed in basipetal succession, but leaving the apex of the placenta and the part next the base of the ovary free. Between the ovules are formed, also basipetally, and after the first appearance of the integuments, emergences of large-celled parenchyma, varying in size with the species, as also does the number of ovules, which is usually larger in the short-styled than in the long-styled form. The ovules are arranged spirally.

In *P. Auricula* and *elatior* the initial cell of the ovule lies beneath the dermatogen, and first divides by an anticlinal wall into two cells, which then divide periclinally, and one or both of the outer segments again anticlinally. The number of rows of cells produced by the periclinal divisions is increased by anticlinal divisions, and the dermatogen-cells are also found to divide anticlinally. When the rudimentary ovule begins to be elevated as a protuberance, periclinal walls are also formed on the apical surface of the protuberance in the first, less often in the second layer beneath the dermatogen and anticlinal walls on its lateral faces in the first layer beneath the dermatogen. No differentiation can yet be detected into periblem and plerome; and the term *endoblem* is applied by the author to the tissue beneath the dermatogen. The endoblem finally forms a small-celled parenchymatous tissue.

The formation of the nucellus is preceded by a radial elongation of the cells of the outermost layer of endoblem, and the ovular protuberance now becomes cylindrical, with a nearly rectangular longitu-

* Pax, F., 'Beitrag zur Kenntniss des Ovulums von *Primula elatior* Jacq. u. *officinalis* Jacq.' 41 pp., Breslau, 1882. See Bot. Centralbl., x. (1882) p. 316.

dinal section. The nucellus is formed only in the lateral, not in the terminal corners. The two integuments are formed at the same time on one side only around and not out of it, appearing first at the apical edge of the longitudinal section, and growing also more rapidly here than at the parts nearest to the base of the ovary. The inner integument is clearly formed before the outer one. Both are developed out of the dermatogen, while in other genera it is only the inner one that has this origin.

In the formation of the integuments an elongation of two cells in the case of the outer, of three in the case of the inner integument takes place on the dorsal side, their cells being separated from one another by a single cell. The elongation takes place in two slightly different directions. The outer integument is then formed on the dorsal side by the growth of the apical edge of the two cells, on the ventral side by periclinal and anticlinal divisions of originally at most five cells. The inner integument is formed on both sides out of three cells, the central one of which usually divides periclinally, the two outer ones by oblique walls.

The thickening of the outer integument takes place by divisions parallel to the longitudinal axis in those cells which form at the time its innermost layer; the inner integument is formed also in a similar way, and becomes considerably thicker than the outer one. The cells of the innermost layer of the inner integument subsequently elongate in a direction vertical to the longitudinal axis. Special divisions take place in certain cells on the ventral side in connection with the curvature of the embryo-sac. The ovule of *Primula* is not strictly anatropous, but somewhat between the anatropous and campylotropous form.

The origin of the formation of the nucellus consists in three hypodermal cells of the outermost layer of endoblem raising up the four or five dermatogen cells which lie above them, and giving rise to anticlinal divisions. The centre one of these three cells increases much more rapidly, forcing aside the other ones, which are completely resorbed in the epidermis. In the mother-cell of the embryo-sac arise two and subsequently two more transverse walls of considerable thickness and great refrangibility. The lowermost of the four daughter-cells compresses the three others which lie above it, until they finally constitute only a strongly refrangible cap upon the mature embryo-sac. The embryo-sac is fusiform and somewhat crescent-shaped; it contains two synergidæ, an ovum-cell or oosphere, a small "vegetative" nucleus, and three antipodals.

The funiculus is formed out of the original ovular protuberance; its endoblem is differentiated into periblem and plerome. The latter developes into a vascular bundle without xylem, composed only of cambiform, which ends directly at the embryo-sac. The periblem is at first composed of a single layer of elongated cells, later of two layers, and finally of large cells destitute of protoplasm.

Homology of the Ovule.*—L. Celakovsky gives a very minute description of a case of phyllody of the ovules of the columbine;

* Bot. Centralbl., x. (1882) pp. 331–42; 372–82 (1 pl.).

discusses at great length the various theories as to the homology of the ovule and of its parts; and finally adduces arguments in favour of his previously published view that the ovule is homologous to a pinna or section of a leaf (foliolum). The ordinary position of the nucellus in the ovule is at first terminal; and it sometimes also occupies this position in monstrosities, especially when the ovular leaflet does not assume a distinctly foliar character. But when phyllody is strongly manifested, it is seen that the nucellus is not the true apex of the foliar leaflet, having a superficial lateral position. The morphological value of the nucellus is not affected by the question whether it originally occupies or only subsequently assumes a lateral position.

Phytoblasts and their Pseudopodia.*—According to Prof. H. Baillon every vegetable or vegetable organism commences its existence as a phytoblast, the life of which may go through distinct periods, and which may have various degrees of complexity of structure. The phytoblast is of an albuminoid nature, like the lowest animals; and its reactions are proteid. Like truly animal substances, it is attacked by ammonia and by other special reagents; and behaves in every respect like animal sarcode. With its movements are associated pseudopodia, produced at the expense of its substance, usually internal, less often external. The movement of these pseudopodia is ordinarily slow, but sometimes more rapid, acting as arms to extend the organism to any neighbouring locality where the conditions may be especially favourable for its nutrition.

During the growth of the pseudopodia cavities are formed inside it through which circulate a variety of nutrient fluids, one of these being the chlorophyll-pigment, though many phytoblasts are entirely destitute of it. Another frequent product of the phytoblast is the phytocyst, an external envelope of cellulose, mixed with a certain proportion of the superficial proteid substance; but which must be regarded only as a kind of carapace belonging to the moneroid structure which represents the phytoblast.

A favourable object for observing the structure and movements of these pseudopodia is the hairs at the base of the stamens of Ficoideæ; within which are seen, in favourable conditions, protoplasmic structures with a rapid oscillating motion resembling that of vibratile cilia. These pseudopodia coalesce when they meet, and the internal microsomes move rapidly from one to another. The author compares this movement to that of plasmodia, and regards it as forming an argument in favour of the animal nature of these phytoblasts or phytozoaires.

Formation of Pollen-tubes.†—J.B. Schnetzler places pollen-grains of *Narcissus poeticus* in the mucilage from the stem of the plant. After about two hours, pollen-tubes begin to be formed, in which, at a temperature of 13° C., currents of protoplasm are very evident. The tubes thus formed vary greatly in form and dimension, while those

* Bull. Soc. Linn. de Paris, 1882, pp. 297–8 and 313–4.
† Bot. Centralbl., xi. (1882) pp. 104–5.

formed in the conducting-tissue of the stigma are moderately uniform. Pollen-grains of *Leucojum æstivum* immersed in the same way at 7 A.M. began to put out their tubes at 10.30; about 11.30 the tubes were twice as long as the grains; about 12.0 three times as long, and at 2 P.M. ten times as long as the grains; increasing in length about 0·1 mm. per hour. If the mucilage is too watery, the grains are liable to burst. Tinting with carmine-ammonia exhibits the development of the pollen-tubes very well when the mucilage in which they are immersed is sufficiently fresh.

Cause of the Movement of Pollen-tubes.*—The penetration of pollen-tubes into the conducting tissue of the style is attributed by Sachs to unequal growth of the two sides; A. Tomaschek, on the contrary, considers it to be due to hydrotropism. When masses of pollen of *Colchicum autumnale* are placed in a hollow plum from which the stone has been removed, the pollen-tubes from the uppermost grains rise erect, while those which lie at the side incline downwards. Pollen-grains made to germinate in the open air display curvatures and even spiral windings, closely analogous to those of tendrils, which can scarcely be assigned to any other cause than revolving nutation.

Apical Growth of the Roots of Phanerogams.†—S. Schwendener gives the following summary of results of his own and of previous investigators on this point:—

1. Most dicotyledons have a formative tissue over the apex of the root, the innermost layer of which is the young epidermis, the remaining layers belong to the root-cap. The originally simple row of cells of which the epidermis is composed splits into two; the inner, and sometimes the outer one of these again divide. In a small number of dicotyledons layers of cells split off from the epidermis outwards, constituting the root-cap; the root-cap and the root itself having in these cases a common histogen. The formation of the root-cap is shared by the epidermis, which covers the apex of the root either in an undivided or in a split condition, and by the entire cortex or its outermost portion only. Monocotyledons have distinct histogens for the root-cap and the root itself; the epidermis is not in genetic connection with the root-cap; but there is a common primary meristem for both. Dicotyledons and monocotyledons present therefore this difference; that in the former there is a genetic connection between the root-cap and epidermis, but not in the latter.

2. The author confirms the statement of Eriksson that in dicotyledons the root-cap and epidermis proceed from a common histogen, the "dermacalyptrogen"; although differentiated dermatogen cells take part in the formation of the cap.

3. There is no distinct histogen, as Hanstein asserts, for the vascular cylinder or plerome.

* SB. K. Akad. Wiss. Wien, lxxxiv. (1881) pp. 612–5 (1 pl.). See Bot. Centralbl., xi. (1882) p. 12. Cf. this Journal, *ante*, p. 372.

† SB. K. Preuss. Akad. Wiss., 1882, pp. 123–39 (2 pls.). See Bot. Centralbl., x. (1882) p. 389.

4. As respects the number of apical cells, *Eleocharis palustris* has only one; while the Marattiaceæ have four. Phanerogams most often have several, not unfrequently four. In not a few cases, and especially among conifers and in some Leguminosæ, the line of growth takes a peculiar course. At the apex is a column, the rows of cells which constitute it running parallel to one another and to the axis. This structure is regarded as indicating a transverse meristem composed of equivalent cells.

5. When distinct histogens occur in the apex, the walls which separate them are as thin as those of the histogen itself. Even roots, therefore, possess a special meristem from which branches proceed in two directions having no genetic connection with one another.

Pitchers of Dischidia Rafflesiana.* —M. Treub describes the pitchers of this epiphytal liane, belonging to the Asclepiadeæ, which is rarely seen in Europe. The pitchers are seated on short axillary branches in pairs or opposite to very rudimentary leaves, and are themselves metamorphosed leaves, exactly resembling the ordinary leaves in their earlier stages. In contrast to *Sarracenia* and *Nepenthes*, the outer side of the pitcher corresponds to the upper side of the normal leaves. The whole of the plant with the exception of the stomata, is covered with a close coating of wax, which extends even to the inside of the pitchers, and seems to preclude the possibility of these being organs of nutrition. They contain water, due apparently partly to rain, partly to transpiration. The only animals found in them were ants, which were always alive. Many of the pitchers were penetrated by the abundant adventitious roots; and the only function which could be suggested for them was the accumulation of water, which is conveyed to the plant through these roots.

Influence of Light and Air on the Anatomical Structure of Plants.†—J. Vesque and C. Viet give the following as the main results of experiments on this subject made partly in the laboratory, partly in the open air:—

The combined action of light and of air more or less dry (i. e. of ventilation) is to accelerate the amount of transpiration, and hence (1) to increase the total thickness of the foliage; (2) to promote the development of palisade-parenchyma, either by the increase in the number of layers of cells of which it is composed, or by increasing the length of the cells themselves; (3) to promote an increased development of hairs, both in number and in length.

The authors consider that these effects are produced not by one only of the agents, but by the two combined.

Respiration of Plants.‡—E. Godlewski has made a careful series of experiments on the relations between the gases inhaled and exhaled

* Ann. Jard. Bot. Buitenzorg, iii. (1882) pp. 13–37 (3 pls.). See Bot. Centralbl., xi. (1882) p. 57.

† Ann. Sci. Nat. (Bot.) xii. (1882) pp. 167–76.

‡ Denkwürd. Krak. Akad. Wiss., vii. (1881). See Bot. Centralbl., x. (1882) p. 308.

by plants, chiefly by germinating, starchy, and oily seeds, ripening fruits of *Ricinus communis* and *Papaver somniferum*, and flower-buds of the last species. The following are some of the more important results:—

1. In the germination of both oily and starchy seeds, during the period of swelling, the volume of the exhaled carbonic gas is very nearly the same as that of the inhaled oxygen.

2. When access of oxygen is hindered, as when the swelling takes place under water, intramolecular respiration comes into play; and this may even continue after the seeds are exposed to the direct influence of the air.

3. When, in oily seeds, the roots begin to grow, the quantity of inhaled oxygen begins to show an excess over that of the exhaled carbonic acid. At the time when growth and respiration are most active, about 55–65 parts of carbonic acid are exhaled for 100 parts of oxygen inhaled.

4. The transformation of oil into starch is probably effected by each molecule of oil splitting up into three molecules of starch, together with carbonic acid, water, and other undetermined substances.

5. In the later periods of the germination of oleaginous seeds, not only the oil but also the carbohydrates formed from it, are used up in respiration; in consequence of which the volumes of oxygen inhaled and of carbonic acid exhaled become eventually equal.

6. In the germination of starchy seeds the volumes of the two gases remain constantly nearly the same, varying somewhat with different species.

7. In the case of expanding buds (of *Papaver somniferum*) the volumes of the two gases are the same.

8. In the case of ripening fruits containing oily seeds, a considerably greater quantity of carbonic acid is exhaled than that of the oxygen inhaled, a process of reduction taking place by which starch is changed into oil.

9. Changes in the pressure of the oxygen cause corresponding changes in the energy of respiration.

10. But even when the energy of respiration is affected in this way, no alteration takes place in the relative quantity of oxygen inhaled and of carbonic acid exhaled. The relative proportion is affected only when the pressure of oxygen is so reduced that the amount of this gas inhaled is considerably diminished, giving rise to intramolecular respiration.

11. Intramolecular is no ingredient in normal respiration, which is the result of the direct action of atmospheric oxygen on living molecules of protoplasm; the former taking place only when normal respiration is hindered by a deficient supply of oxygen.

12. Under the ordinary conditions of normal respiration, intramolecular respiration takes place only when a process of reduction is going on at the same time in the plant, as when carbohydrates are being transformed into oil.

Oxalate of Lime in Plants.*—Dr. A. Poli publishes a full account of what is known respecting the occurrence of crystals of calcium oxalate in plants, including a complete list of those species in which they have been found, and a chapter on their physiological value.

Dr. Poli's own observations relate to species from a great number of natural orders, but chiefly from Labiatæ. The presence of calcium oxalate is, he states, no characteristic feature of this class, several genera being altogether deficient in it. When present, it occurs in the greatest abundance in the rachis of the inflorescence. In some species of *Salvia* the crystals appear to be suspended in the cell-contents of the pith and cortical parenchyma, to be endowed with Brownian movement, and to be accompanied by grains of chlorophyll or starch.

The clusters of crystals which occur in the extrafloral nectaries of *Ricinus* are first formed in the nectaries at the base of the cotyledons, around the vascular bundles. The young seedling has no crystals of calcium oxalate within its tissue until it has attained a height of nearly 0·1 m. and its cotyledons are fully developed. There are no crystals in the male flowers of *Ricinus*.

Insects and the Cross-fertilization of Flowers.†—Doubts have been raised by M. Heckel and others, as to the *rôle* of insects in the cross-fertilization of flowers; based especially on their supposed absence, or at least, their great rarity on the flowery summits of high mountains. The results of four years' observations at Grenoble, by C. Musset, at all altitudes from 200 m. to 3000 m., and amidst one of the richest herbaceous floras in the world, are instructive. He finds (1) that all orders of insects have representatives up to 2300 m.; (2) that beyond 2300 m. Lepidoptera, Diptera, and certain Hymenoptera preponderate in number; (3) that the number of genera, species, and individuals of nectar-loving insects is proportional to that of the flowers, and is sometimes incalculable; (4) that the hours of sleep and waking of flowers, and those of insects, are synchronous; (5) that the apparent number of nectar-loving insects is proportional to the number of their favourite flowers, and the state of the atmosphere and sky. M. Musset concludes that, as flowers and insects are never simultaneously wanting, the objection referred to against cross-fertilization is not well founded.

B. CRYPTOGAMIA.

Muscineæ.

Classification of Sphagnaceæ.‡—G. Limpricht explains more in detail the use of the character derived from the relative position of the chlorophyllaceous and the hyaline cells for the classification of species of *Sphagnum*.

* Poli, A., 'I cristalli di ossalato calcico nelle plante' (2 pls.), Rome, 1882. See Bot. Centralbl., x. (1882) p. 311. See also this Journal, *ante*, p. 597.

† Comptes Rendus, xcv. (1882).

‡ Bot. Centralbl., x. (1882) pp. 214–22. See this Journal, *ante*, p. 79.

The chlorophyllaceous cells of the leaves of the branches are compressed between the hyaline cells in one series on the inner, in the other series on the outer side of the leaf, forming, on transverse section, an isosceles triangle, with the free outer wall as its base. In the hyaline cells that wall is in consequence more convex which is more or less in contact with the adjoining hyaline cell at the apex of the triangle, although there is never any actual mutual coalescence. In the same species the prismatic form of the chlorophyllaceous cells may be replaced by a triangular, oval, or even a trapezoid form. In this mode of arrangement two groups may be distinguished :—

1. The chlorophyllaceous cells are compressed between the hyaline cells on the outer side of the leaf; the hyaline cells being therefore more convex on the inner side of the leaf:—*S. recurvum*, P. B., and var. *speciosum* Russ. (*S. spectabile* Sch.); *Lindbergii* Sch.; *molluscum* Bruch; *cuspidatum* Ehrh.

2. The chlorophyllaceous cells are compressed between the hyaline cells on the inner side of the leaf; the hyaline cells being therefore more convex on the outer side of the leaf:—*S. acutifolium* Ehrh.; *rubellum* Wils.; *Girgensohnii* Russ.; *fimbriatum* Wils.; *molle* Sull.; *Austinii* Sull.; *papillosum* and *cymbifolium* Ehrh., with its sub-forms *S. subbicolor* Hampe, and *glaucum* v. Klinggr.

3. In the remaining species of *Sphagnum*, the chlorophyllaceous cells of the leaves of the branches lie exactly in the middle between the hyaline cells; either (1) free on both sides, when they are fusiform or disk-shaped in transverse section, and the hyaline cells equally convex on both sides:—*S. subsecundum*, N. v. E.; *laricinum* Spr., and *contortum* Sch.; or (2) the very small chlorophyllaceous cells are elliptical in transverse section, and are equally enclosed on all sides by the hyaline cells, which mutually coalesce:—*S. Wulfianum* Girg.; *Angströmii* Hartm.; *rigidum* Sch.; and *medium*. The *squamosum* group presents some considerable deviations from this structure.

Fungi.

Leucogaster, a New Genus of Hymenogastreæ.* — In beech-woods in Hesse-Nassau, R. Hesse found a number of fungi belonging to the Hymenogastreæ, a group of Gasteromycetes which comprises the genera *Hymenogaster*, *Rhizopogon*, *Hysterangium*, *Hydnangium*, *Gautieria*, *Octaviania*, and *Melanogaster*. Among them he observed a hitherto unknown form, which he describes under the name *Leucogaster liosporus*, and regards as the type of a new genus which must be placed between *Melanogaster* and *Octaviania*. It resembles *Melanogaster* in the chambers of the gleba being filled with jelly in consequence of the swelling of the basidia; *Octaviania* and *Hydnangium* in the form of the spores; but differs from all the other Hymenogastreæ in the structure of the membrane of the spores.

The mycelium is not very massive, and consists of thin, at first colourless, septated, branched hyphæ with very thick walls and occa-

* Pringsheim's Jahrb. wiss. Bot., xiii. (1882) pp. 189–94.

sional swellings. The fructification varies greatly in form and in size from that of a pea to a pigeon's egg. The peridium of the mature fructification is from 1·5 to 2·5 mm. thick, smooth, and composed of densely packed yellowish hyphæ. The white shining chambered gleba resembles in structure that of *Melanogaster* and *Hysterangium*. The trama is readily distinguished from the hymenial hyphæ, and is composed of a mass of extremely thin shining filaments, of which the hymenial filaments are elongated unseptated branches. The chambers of the gleba are usually polygonal, and are filled, as in *Melanogaster*, with jelly resulting from the swelling of those basidia which have already produced spores. The ripe spores are yellow, and about 0·02 mm. in diam. They are produced in the ordinary way in fours on the basidia, but without sterigmata. The membrane eventually separates into two layers, an exospore and an endospore; the exospore finally deliquesces into jelly; so that the ripe spore is at length surrounded with a smooth gelatinous transparent envelope, investing it like a sac. The spores contain a dense fine-grained protoplasm, with small drops of oil.

Parasites of the Human Ear.*—Loewenberg states that otomykosis frequently results from the introduction into the ear of the mycelium of fungi through the medium of ordinary oily substances such as olive-oil, oil of almonds, balsam, pomade, &c.; and he recommends as a substitute for these glycerine, which is not liable to the same objection. Disease is also caused by the occurrence of mycelial filaments in liquid medicinal applications, such as tannin, alum, zinc-vitriol, &c. The most extreme care must consequently be taken as to the purity of fluids for dropping into the ear, especially where the drum is perforated.

He also adduces a case of ophthalmomykosis apparently caused by the presence of mycelial filaments in solutions of atropine and chlorine. The use of alcoholic in preference to aqueous solutions is recommended wherever practicable; where the latter are indispensable, they should be boiled, or kept in so concentrated a state that the mycelia or spores of fungi cannot retain in them their power of growth, and diluted with freshly boiled water immediately before using.

Chromogenous Schizomycete on Cooked Meat.†—In some experiments carried out by J. B. Schnetzler, pieces of fresh boiled beef, tendons, bones, and fat, exposed to the air but protected from light, became completely covered with a coating of a beautiful fuchsin-red colour. With an immersion lens magnifying 750 diam., this was seen to be composed of a gelatinous mass in which were imbedded multitudes of globular *Micrococcus*-cells about 1 μ in diam. These presented all stages of transition between *Palmella mirifica* Rabh., and *P. prodigiosa* Mont. (*Micrococcus prodigiosus* Cohn, *Monas prodigiosa* Ehrenb., *Zoo-*

* Loewenberg, 'Des champignons parasites de l'oreille humaine.' Paris, 1880. See Bot. Centralbl., x. (1882) p. 405.

† Bull. Soc. Vaud. Sci. Nat., xviii. (1882) pp. 117–9.

galactina imetropha Sette, or *Bacteridium prodigiosum* Schröt.); and Schnetzler believes Rabenhorst's *Palmella mirifica*, described as occurring in similar situations, to be but a form of Cohn's *Micrococcus prodigiosus;* the differences in the size of the cells and in the coloration being due to its occurrence on an animal instead of a vegetable substratum. The presence or absence of a gelatinous matrix is no distinctive character between the two species. During the formation of the red gelatinous matter on the meat, the temperature varied between 25° and 30° C. Cold alcohol extracted the colouring matter; the rose-coloured solution became greenish yellow on addition of ammonia, acids colouring it red. Spectrum analysis showed a broad absorption-band in the green.

We have therefore here a chromogenous Schizomycete which possesses the remarkable property of producing colouring matters from the elements derived from the substratum and from the air at a suitable temperature.

New Bacterium sensitive to Light.*—Among the Schizomycetes which T. W. Engelmann has previously studied, with respect to the action of light, only one was sensitive to this action. This form, called on account of its colour, *Bacterium chlorinum*,† disengaged oxygen in the light, and probably for this reason was attracted to the light when oxygen was deficient. He found, last year, a second form *Bacterium photometricum*, which reacted in a very high degree under the influence of light. It is slightly reddish in colour. The microspectroscopic eye-piece shows a powerful absorption of all the rays whose wave-length is less than $0 \cdot 62\ \mu$, especially those between $0 \cdot 62$ and $0 \cdot 59$ (orange).

The influence exercised by light on *B. photometricum* differs very remarkably, in many respects, from that shown by other motile organisms.

In the first place the *rapidity of the movements* depends on it.

In *light of constant intensity* the rapidity of the movements is, generally, in direct proportion to the luminous intensity; more rapid, *ceteris paribus*, in the ultra-red and orange of the light of the sun or of gas, than in the other regions of the spectrum.

In the case of *prolonged action of light*, especially of an intense light (and chiefly of the ultra-red and orange), the greater number of the bacteria become quiescent, this taking place directly when the ventilation is imperfect. This repose may be disturbed (all the quicker when it has been of shorter duration) not only by darkening, or a change of colour which acts in the same way, but also by any appreciable increase of light.

When the *luminous intensity diminishes suddenly*, or when its *quality* (the wave-length) undergoes a change acting in the same way, the bacteria quickly retire, then stop for a time, and presently recommence their movements.

The *positive changes of the intensity or of the colour of the light* do

* Rev. Internat. Sci. Biol., ix. (1882) pp. 469–70.

† See this Journal, *ante*, p. 380.

no more than accelerate the movements, even when they are very great and rapid.

The *direction* of the movements of progression changes in proportion with the *intensity* and *colour of the light.* In general, the bacteria move from less illuminated points to those which are more so, or from less active rays to those of greater activity. The converse only takes place when the luminous action is very intense. This results as much from experiments with glasses and coloured liquids as from observations in the objective microspectrum.* In this spectrum, the bacteria accumulate chiefly in the ultra-red and in the orange-yellow. A third maximum (much weaker) is found in the green.

In the spectrum of gas-light, the accumulation in the ultra-red is much stronger than that in the yellow; in the spectrum of solar light, the ultra-red only possesses a slight advantage in this respect. The crystalline lens and the aqueous and vitreous humours of four bullocks' eyes in a fresh state, having been placed in a series between the gas-flame and the microspectral apparatus, this intercalation had no perceptible influence on the accumulation in the ultra-red; it was the same on interposing a solution of alum in thick layers.

The *direction of the incident light* appears to have little or no direct influence on the direction of the movements.

Engelmann at first supposed that *B. photometricum* disengaged oxygen under the influence of light, and that the phenomena described might be essentially referred to modifications in this production of oxygen; but this presumption has not been verified. It has been impossible to prove a disengagement of oxygen. The bacteria are also, relatively, but little sensitive to differences in the tension of the oxygen; nevertheless, the increase of this tension acts, in almost all respects, in the same way as the increase of the light, and *vice versâ.* The addition of a little CO_2 acts in the same manner as a sudden darkening.

What seems most probable is that light excites in bacteria a specific chemical process of a reducing character, a process comparable consequently to assimilation. Special experiments have shown that the action of the light cannot be attributed to changes of temperature.

Connection of the Bacilli of Hay and of Distemper.† — In pursuance of his experiments on the mutual conversion into one another of the bacilli of distemper and of infusion of hay, H. Buchner reports the following results of experiments.

The original form from which the distemper-bacilli were obtained, the bacterium generated in infusion of hay, and distinguished by the name *Bacterium subtile*, is marked by an extraordinary power of resistance to high temperature, and by having no power of causing fermentation; requiring, therefore, for its nourishment free oxygen. The distemper-bacteria retain their infectious properties as long as desired at a temperature of 25° C. in solution of extract of meat,

* See this Journal, *post*, p. 661.

† SB. Akad. Wiss. München, 1882, p. 147. See Naturforscher, xv. (1882) p. 251. Cf. this Journal, *ante*, p. 89.

where they have the form of cloudy masses at the bottom of the perfectly clear nutrient fluid. If the temperature is raised to 36°, and the supply of oxygen increased by shaking, they multiply more rapidly, and at the same time gradually lose their infectious properties.

In order to convert the distemper-bacteria rapidly into hay-bacteria, the solution which contains them is shaken up violently, to increase the supply of air, in a vessel to the sides of which pieces of filtering paper are stuck. Three transitional forms are thus obtained, which finally pass over into the bacteria of hay. The change is greatly promoted by the addition to the solution of extract of meat, of yolk of egg, and a small quantity of alkali. After standing for about 24 hours at a temperature of 36° C., a transitional form, the bacteria of white of egg, is obtained, which, in a slightly acid infusion of hay, is transformed into the innocuous hay-bacteria.

The following is an epitome of the behaviour of these three interchangeable forms of bacteria, which Buchner regards as adaptive forms of one and the same organism, *Bacterium subtile*:—1st medium. 1 per cent. extract of meat—(*a*) distemper-bacteria: solution clear, clouds at the bottom; (*b*) white-of-egg-bacteria: solution cloudy, flocculent, a mucilaginous pellicle, flocks and pieces of pellicle at the bottom; (*c*) hay-bacteria: solution clear, with a firm, white, dry pellicle difficult to submerge. 2nd medium. Slightly acid infusion of hay. (*a*) no increase; (*b*) formation of a sparse white rim on the surface of the fluid; (*c*) dry pellicle, moistened with difficulty, and usually with a wrinkled or pulverulent appearance. 3rd medium. The bodies of animals. (*a*) Infectious in very small quantities, producing distemper; (*b*) when multiplied a thousandfold, inactive; in still greater quantities, infectious, producing distemper; (*c*) inactive even when present in the greatest quantities.

Diffusion of Bacteria.—The researches of Pasteur and Darwin have shown how earthworms may aid the diffusion of small organisms, some of which may produce disease. Professor J. B. Schnetzler states that the dejections of earthworms always contain numerous living bacteria and their germs (the hay-bacterium included). It is clear that bacteria in enormous quantity float in the air about us; and we have at easy command, Professor Schnetzler points out, a small apparatus traversed by about 8000 cubic centimetres of air per minute, which may inform us as to those floating germs. This is no other than the nasal cavity, on the mucous surface of which air-particles are deposited. To observe these he advises injecting the nose with distilled water (completely sterilized) by means of a glass syringe previously calcined. The liquid so obtained is put in one perfectly clean watch-glass and covered by another. With a Microscope magnifying 700 or 800 one finds, among various particles in the liquid, some real live bacteria. If the liquid be kept a few days in a clean glass tube hermetically sealed the bacteria are found to have increased very considerably. One sees *Bacterium termo*, *Vibrio*, *Spirillum*, *Bacillus subtilis*, even some *Infusoria*, and spores and fragments of fungi.

Professor Schnetzler has further successfully cultivated the organized germs by means of a mixture of gelatine and distilled water. Why do not these bacteria in the nasal cavity always multiply and develope and penetrate to the windpipe and lungs? Their progress is doubtless opposed by the vibratory movements of cilia in the air-passages, and the weakly alkaline reaction of the nasal mucus may (it is also suggested) be unfavourable to some of them. Cohn has proved that bacteria producing acid fermentation perish in liquids with alkaline reaction. Infectious bacteria may, however, multiply to a formidable extent on living mucous surfaces; witness the growth of the micrococcus of diphtheria, brought by the air into the air-passages; also the bacterium of anthrax. The bacillus of tubercle, as Koch has lately shown, may be transmitted from one person to another by the air-passages. Professor Schnetzler thinks hay fever may also be due to bacteria entering the nose. While the development of bacteria on normal mucous surfaces is usually limited, millions of them are found in the dejections of healthy children.

Parasite of Malaria.* — From observations on a considerable number of malaria-patients, M. Richard is able to state that in all cases a specific organism is present. It inhabits and undergoes development in the red corpuscles of the blood; the first indication of its presence within the corpuscle is a pale spot which grows and developes black granules at its periphery; it ultimately occupies the whole interior of the corpuscle, and then it ejects a collar with dark granules, and one or more delicate marginal processes; this is the parasite. It often oscillates with great energy for about an hour, even when not quite free from its host. The collar breaks up and sets free the granules which may be taken up by the white corpuscles. The "body No. 1" of Laveran appears to be a corpuscle containing a parasite whose development has been arrested. The comatose stage of the disease is produced by the blocking of the cerebral capillaries by blood-corpuscles containing parasites, in which condition they are very viscous and have lost their usual great elasticity. The appearance of the corpuscle when affected appears to demonstrate the existence of an investing membrane outside it. When the parasite is not abundantly present, Richard uses acetic acid to destroy the normal corpuscles, thus leaving the few affected ones readily visible.

Parasitic Character of Cases of Malaria.†—A. Laveran's account of this matter should be compared with that of Richard given above. He describes from the blood of malaria-patients three forms of parasitic elements.

1. Cylindrical bodies, with filamentous extremities, usually crescentic; length 8–9 μ, diameter on an average 3 μ. Contour marked by a very fine line; body transparent and colourless, except at the middle, where there is a blackish spot composed of very dark red

* Comptes Rendus, xciv. (1882) pp. 496–9.

† Ibid., xciii. (1881) pp. 627–30. Cf. Rev. Internat. Sci., iv. (1881) pp. 459–61.

pigment-granules. A very fine line is sometimes observed at the side of the cavity, and apparently serves to support the extremities of the crescent-shaped body. No movements appear to take place. The form is sometimes oval; and when it is but slightly elongated and the granules arranged in a circle, it closely resembles the other two forms. 2. Spherical transparent bodies, of the average diameter of a red blood-corpuscle, with pigment-granules often arranged in a circle when the body is inactive; in movement, they are agitated vigorously and become irregular in arrangement. At the margins very delicate filaments, slightly inflated terminally, often appear to be inserted; they move rapidly in every direction; they have a length of from three to four diameters of a red corpuscle; three or four may occur upon one body; they cause an oscillation of the body, and displace adjacent blood-corpuscles. They finally become detached from the spherical bodies, and then range freely among the blood-corpuscles. 3. Spherical bodies of irregular form, transparent or finely granular, 8–10 μ in diameter, containing rounded pigment-granules of a very dark red colour, sometimes arranged regularly near the periphery, sometimes aggregated at the centre or near the periphery. They are immobile, both as wholes and in their parts. They have been observed to result from the transformation of the body No. 2, and are probably the form which it takes at death. They have no nuclei, and are with difficulty stained with carmine. 4. Spherical transparent bodies like (2), but much smaller, viz. the smallest scarcely the $\frac{1}{6}$ of a red corpuscle in diameter, and containing only one or two pigment-granules each; the largest have almost the diameter of a red corpuscle. They occur either free or aggregated variously or attached to blood-corpuscles and appear to represent a phase in the development of the above parasitic bodies. Besides these four types, there occur red corpuscles exhibiting perforations and pigment-granules, dark leucocytes, and free pigment-granules of various sizes.

Out of ninety-two cases of palustric diseases of different kinds, these parasitic elements were detected in forty-eight, and their absence in many of the remaining ones may be due to the action of sulphate of quinine which had been administered to most of these, and which has been ascertained to have the power of destroying the parasite in blood removed from the body. The bodies cannot always be detected, they are most readily obtained just before the attack of fever and at its termination; in chronic cases, they sometimes exist permanently in the blood. In the intervals between the attacks they probably lie in the internal organs, especially the spleen and liver. Pigment-bodies always occur in great numbers in the blood, especially of the small splenic and hepatic vessels, of subjects that have died of palustric affections. When death takes place owing to accidental circumstances, the bodies are found in such quantities in the blood as to tinge the spleen, liver, marrow of the bones, and sometimes the grey matter of the brain, a brownish, quite characteristic colour. Thus the dangerous symptoms of malarial

diseases are produced by parasitic elements which occur under different forms in the blood.

Vaccinal Micrococci.—M. Straus presented to a recent meeting of the Société de Biologie at Paris a series of microscopical preparations of the vaccinal pustule from the calf, at different stages of its progress, in which the presence of the special micrococcus could readily be observed. The method of preparation adopted was to place the excised fragments of skin in absolute alcohol, to cut sections and stain them by Weigert's method (methylamine violet), and then discolouring them until only the nuclei, the bacteria, and micrococci remain visible. Under a high power, the latter were visible as extremely minute points, tinted blue, about a thousandth part of a millimetre in diameter, and grouped in colonies. They were seen in the borders of the inoculation wound, and in the Malpighian layer, and subsequently could be traced passing into the subjacent cutis, especially in the lymphatic spaces. The multiplication and extension of the organism seemed to coincide closely with the development of the pustule.

Mucorini.*—Professor G. Bainier has published a useful monograph on these fungi. In a general introduction he briefly considers the systematic position of the Mucorini, their reproductive organs, mode of life, and methods and results of cultivation. The bulk of the work is occupied with the description of the species, twenty-seven of which are figured. It concludes with remarks on the importance of the Mucorini in the economy of nature.

Algæ.

Disengagement of Oxygen by Vegetable Cells in the Microspectrum.†—T. W. Engelmann describes experiments on this subject. He has studied the relation between the wave-length and the assimilative action of the luminous rays by the "bacteria method." ‡ For this purpose he has made use of a microspectral apparatus, constructed under his directions by Zeiss of Jena. The apparatus forms a microspectrum at the plane of the object on the stage, and replaces in use the ordinary illuminating apparatus (mirror and diaphragm) of the Microscope. It is composed of, 1st, a plane mirror; 2nd, an arrangement with two slits, viz. *a*, a slit, with *both* sides movable by means of a micrometric screw and the breadth of which can be adjusted (with a range of 2 mm.) to about ·001 mm. *b*. A slit movable, perpendicular to *a*; 3rd, a collimator lens; 4th, a direct-vision prism; 5th, an objective forming the spectral image of the slit. As it is useful to be able to vary the absolute size of the

* Bainier, G., 'Etudes sur les Mucorinées.' 4to, Paris, 1882, 136 pp. and 11 pls. See very full abstract by Dr. Zimmerman in Bot. Centralbl., xi. (1882) pp. 115–32.

† Rev. Internat. Sci. Biol., ix. (1882) pp. 465–7. Pflüger's Arch. f. Physiol., xxvii. (1882) p. 485. Bot. Ztg., xv. (1882) pp. 419–26 (1 fig.).

‡ See this Journal, i. (1881) p. 962.

spectrum, it is advisable to have several different objectives. The sharpness of the spectra is such that some hundreds of Fraunhofer lines can be made perfectly visible. The luminous intensity, even when an ordinary gas-flame is used, is sufficient with a slit of 0·01 mm. wide to observe bacteria under a high power. By replacing the prism by a grating, the apparatus may also be adapted in a simple manner to the formation of a microscopic *interference* spectrum. The results now communicated were obtained by means of the *prismatic* microspectrum. The first question examined was that of the relative extent of the disengagement of oxygen by the green cells in the different regions of the spectrum. In this examination two methods can be adopted, viz.—1. The method of simultaneous observation. 2. The method of successive observation.

Simultaneous Method.—This consists in observing simultaneously the action of the different rays of the spectrum on different juxtaposed points of the same object. The object should have a regular structure. *Confervæ*, *Oscillariæ*, and some diatoms, are especially suitable. The object is placed in a transverse position in the microspectrum, that is, perpendicularly to the direction of the Fraunhofer lines. The following are the phenomena then observed.

When the luminous intensity increases, starting from zero, the bacteria in repose in the immediate neighbourhood of the green cells begin to move first of all in the *red*, most frequently between B and C, and nearer to the latter. Increasing the intensity of the illumination, the action extends on both sides to the commencement of the ultra-red and as far as the violet. The accumulation of the bacteria and the rapidity of their movement, remain in the beginning at their maximum in the red. With green cells (*Euglena*, *Œdogonium*, *Cladophora*), but not with brown (diatoms) and blue-green (Oscillarieæ), there appears in sunlight (not in gaslight) a minimum in the green about E and a second maximum about F. When the bacteria are numerous, we see in such cases a kind of graphic representation of the relation between the wave-length and the assimilative energy, in which the abscissæ are represented by the object and the ordinates by the respective depths of the layer of bacteria.

In the case of very great luminous intensity the differences are reduced, because then the accumulation and the rapidity of movement become very great at all points.

If, starting from the maximum, the luminous intensity decreases gradually, the different aspects just described are reproduced in inverse order.

Successive Method.—In this method the object (preferably very thin) is placed successively in different parts of the spectrum, determining each time the narrowest width of the slit at which the bacteria begin to move. The results confirm in general those of the first, as is shown by two tables given by the author.

In one respect, viz. the situation of the maximum, the results of Engelmann differ very remarkably from those hitherto obtained by macroscopic methods by the best observers (Draper, Sachs, Pfeffer). These authors attribute to the *yellow* rays the strongest assimilative

action.* This difference depends, he thinks, specially on the fact that with the previous methods it was necessary to operate on entire plants or leaves. We then have to deal with a greater or less number of superimposed layers of chlorophyll. Those chlorophyll-grains alone which are nearest to the surface receive the light almost unaltered; on those which are deeper down the absorption produced by the first makes its influence felt. But this absorption is chiefly exerted, as is already proved by the microspectral analysis of a single grain of chlorophyll, on the rays between B and C, which, according to Engelmann's experiments, are precisely those which are the most active, as well as the blue at F. On the other hand, the oxygen disengaged by the superficial chlorophyll-grains being generally only a small fraction of the total production of oxygen in the plant, it follows that the maximum action of the whole plant can no longer fall between B and C (and at F), but must be displaced in the direction of the green.

The justice of this view has also been proved by experiments in which the light, before falling on a cell, has to traverse a thin layer of a solution of chlorophyll. With certain thick cells, very rich in chlorophyll (*Cladophora* for instance), the densest accumulation and the most rapid movement of the bacteria may be seen to be *above* the cell towards the yellow, and *below* the cell in the red.

Disengagement of Oxygen by Hæmatococcus.†—The question whether the red unicellular algæ can assimilate without chlorophyll has been lately decided by J. Rostafinski ‡ in the affirmative, for reasons, however, which are not conclusive. T. W. Engelmann has examined this question by the bacteria-method, § and has obtained, even with specimens of a pure red apparently completely destitute of chlorophyll, a very marked reaction on the bacteria. The disengagement of oxygen was often tolerably brisk, especially in red light. The comparison of a great number of specimens of different colours showed however that, *ceteris paribus*, the disengagement of oxygen was so much the more considerable according as there was the more yellow or green observable in the colour of the cells. This gives rise to the presumption, that, even in cells apparently containing only red colouring matter, chlorophyll may still exist. By means of the microspectroscopic eye-piece of Zeiss, it has been found that there is in the spectrum of these cells a dark space corresponding to the chlorophyll-band between B and C. In the cells of the purest red this band was faintly visible only with a particularly favourable illumination; it became more distinct in proportion to the greener appearance of the cells.

In view of these facts, it must be admitted that the above-mentioned absorption-band does not belong to the red colouring-matter, but arises from chlorophyll associated with this matter, and it may be considered as very probable that even the entirely red individuals of the genus *Hæmatococcus* only assimilate because they still contain chlorophyll.

* See amongst others, Pfeffer, 'Pflanzenphysiologie,' i. (1881) p. 211 *et seq.*, fig. 29.
† Rev. Internat. Sci. Biol., ix. (1882) pp. 468–9.
‡ Bot. Ztg., xxxix. (1881) p. 461. This Journal, i. (1881) p. 930.
§ See this Journal, i. (1881) p. 962.

Hydrurus.*—J. Rostafinski gives the following diagnosis of this little-known genus of algæ, which forms brown slimy flocculent masses in cold rapidly flowing water:—"Thallus hydrobius, lubricus, disco conico affixus, elongatus, usque ad tres decimetros longus, ex uno podio principali, in medio latissimo, ramos laterales emittens; inferne simplex, plerumque nudus, primo intuitu gelatinosus, in tactu duriusculus sed elasticus, solidus aut rarissime senilitate canescens; semipellucidus, ochraceus; superne aut simplex aut penicillatus, varioque modo divisus; semper tota sua superficie, ramulos minores filamentis tenuissimis obtectos, ex olivaceo fuscos aut nigros producens."

The peculiar mode of reproduction takes place only by night. The lower branches of the thallus begin to swell, and the gelatinous matrix of the cell-walls deliquesces and at length altogether disappears. The brown endochrome, previously in the form of bands or caps, collects into globular bodies which at length pass into a tetrahedral form, furnished with projecting ridges or beaks. These develope directly into a new thallus.

The nearest ally of *Hydrurus* is Woronin's genus *Chromophyton*,† which does not necessarily inhabit the leaves of *Sphagnum*. The two genera agree in their gelatinous deliquescent cell-walls; but the reproductive bodies of *Chromophyton* have more the character of zoospores. Rostafinski proposes to unite them into a new family under the name Syngeneticæ.

Relationship of Palmella to the Confervaceæ.‡—Colonies of *Palmella uvæformis* Ktz., gathered by J. B. Schnetzler in a small stream near Lausanne, were found to be composed of minute cells, about 0·01 mm. in diam., congregated into a gelatinous mass. Placed in spring water, and covered with a watch-glass, they produced zoospores, which swam about with great activity, and finally formed a green coating on the sides of the glass. After a time they germinated, and developed into a green alga composed of branched filaments of elongated cylindrical cells with lateral excrescences. Similar filaments also developed directly from the gelatinous cells of the *Palmella*. On evaporating, the cells separated from one another, assumed a globular form, and transformed themselves back again into gelatinous colonies of *Palmella*. The filaments thus produced were a *Stigeoclonium*, or some nearly allied confervaceous alga. The water-bed in which the *Palmella* was originally found was sometimes full of stagnant or running water, sometimes completely dry; at that time the alga was accompanied by quantities of diatoms and by crystals of calcium carbonate.

These observations complete others previously made by Cienkowski and Famintzin on the disintegration of *Stigeoclonium* and of another confervaceous alga into *Protococcus*-cells, which have led Kützing and

* Rostafinski, J., 'Hydrurus u. seine Verwandschaft.' 34 pp. (1 pl.) Krakow, 1882.

† See this Journal, i. (1881) p. 100.

‡ Bull. Soc. Vaud. Sci. Nat., xviii. (1882) pp. 115–6.

others to the conclusion that the genera *Palmella*, *Protococcus*, and *Pleurococcus* are simply phases in the cycle of development of higher algæ.

Division of Closterium intermedium.*—J. Schaarschmidt describes the mode of division of this desmid as analogous to that of *Penium interruptum.* It has a primary suture, and a secondary suture in the middle of each hemicyst; and these present structures similar to the caps of *Œdogonium.* Before each division the cuticle is raised from the cell-wall in the form of a ring hollow on the inside, which splits on division, while the very plastic cell-wall rapidly stretches. The number of secondary and tertiary sutures, &c., may be very considerable, the author having noticed as many as twenty-four rings, indicating the number of times that the individual divides. He believes that all other species of *Closterium* with secondary sutures divide in the same way.

Diatoms from the Island of Lewis.—Mr. E. W. Burgess sends the following list made from the examination of a diatomaceous deposit, new to Great Britain, from the island of Lewis, near Stornoway, which he thinks may be of interest to those working out similar deposits. It was found in the possession of J. Thompson, who was using it to polish sections of corals. The list has been submitted to Dr. Stolterfoth, of Chester, for verification of most of the species.

Abbreviations:—*vr.* (very rare), signifies that only one or two valves have been found; *r.* (rare), about one on each slide; *c.* (common), three or four on a slide; *vc.* (very common), the form most often met with on the slides. Prof. H. L. Smith's arrangement has been followed.

Tribe 1, Raphidieæ. Family 1, Cymbelleæ. *Cymbella helvetica* Ktz. c.; *C. maculata* Ktz. r.; *C. scotica* W. Sm. c. Family 2, Naviculeæ. *Mastogloia* sp. vr.; *Stauroneis anceps* Ehr. r.; *S. Phœnicentron* Ehr. vr.; *S. punctata* Ktz. vr.; *Navicula* (including *Pinnularia*); *N. angustata* W. Sm. c.; *N. acuta* W. Sm. c.; *N. firma* Ehr.? vr.; *N. Hebes* Ralp. c.; *N. interrupta* W. Sm. r.; *N. gibba* Ehr. r.; *N. major* Ehr. r.; *N. ovalis* W. Sm. vr.; *N. rhomboides* Ehr. vc.; *N. viridis* W. Sm. c.; *N. viridula* W. Sm. vr. Family 3, Gomphonemeæ. *Gomphonema acuminatum* Ehr. c.; *G. capitatum* Ehr. vr.; *G. constrictum* Ehr. vr.; *G. intricatum* Ktz. r. Family 5, Cocconideæ. *Cocconeis placentula* Ehr. vr.; *C. Thwaitesii* W. Sm. vr.

Tribe 2, Pseudo-Raphideæ. Family 6, Fragilarieæ. *Epithema gibba* Ktz. vc.; *E. proboscidea* W. Sm. c.; *E. ocellata* Ktz. c.; *E. rupestris* W. Sm. c.; *E. sorex* Ktz. c.; *E. turgida* W. Sm. r.; *E. zebra* Ktz. r.; *Eunatia diadema* Ehr. vr.; *E. tetradon* Ehr. c.; *Himantidium arcus* W. Sm. vc.; *H. bidens* Ehr. vc.; *H. undulatum* W. Sm. r.; *H. majus* W. Sm. vc.; *Synedra splendens* var. *danica* *O'Meara* J. D. vr. Family 7, Tabellarieæ. *Tabellaria fenestrata* Ehr. c. Family 8, Surirelleæ. *Tryblonella angustata* W. Sm. r.;

* Magyar Növénytani Lapok, 1881. See Hedwigia, xxi. (1882) p. 92.

Surirella linearis W. Sm. vr.; *S. nobilis* W. Sm. c.; *Nitzschia linearis* W. Sm. vr. Family 10, Melosireæ. *Melosira nivalis* W. Sm. = *Coscinodiscus Smithii* vr. Family 15, Coscinodisceæ. *Cyclotella antiqua* W. Sm. c. Also a form that for want of better objectives Mr. Burgess is unable to identify beyond that it is an *Odontidium* or *Navicula*.

MICROSCOPY.

α. Instruments, Accessories, &c.

Bausch and Lomb Optical Co.'s Professional Microscope.—Fig. 113 (sent from America, and one of the best woodcuts of a Microscope which we have seen) shows the "Professional" Microscope of the above Company.

Its specialities are the frictionless fine adjustment (described at p. 683), the glass stage and slide-carrier (described at p. 687), the centering of the substage (of which we have no detailed description), the two draw-tubes which allow of more than the ordinary variations of length, and the mirror and substage bars which are separate and can be moved independently of one another, or simultaneously when the arm on the mirror is placed in a recess in the substage bar.

Bulloch's Newer Congress Stand.*—This (Fig. 114) is made upon the original plan,† with the exception of the stage, the construction of which has been modified.

The stage (Fig. 115, Nos. 1-4) is held by a saddle-piece which is steadied by a strong brace passing down from the limb. It is entirely independent of the swinging of the mirror and substage. This saddle-piece contains a set of screws with perforated heads for centering the ring which supports the stage. These screws are so far back that the ring can be made very thin without reducing the strength or rigidity. The stage rests upon this ring. It rotates, and can be accurately centered by the screws in the saddle-piece.

This stage is a revival of an idea which Mr. Bulloch says was used by Spencer thirty years ago. It consists of the ordinary stage-plate, having in its centre a large square hole. One side of this plate contains a wide dovetailed groove, in which slides a bar with its surface level with the top of the plate. At right angles to this bar is attached another bar. On this second bar slides a third bar, into which it has been dovetailed. The motion of this third bar is at right angles to the motion of the first. A thin plate is attached to the third bar, and lies flat upon the stage-plate. This plate is perforated, and holds the slide by means of a spring. It will be seen that this arrangement permits of motion of the thin plate in two directions at right angles to one another. Two pinions, perpendicular to the stage, control

* Cf. 'National Scientific Journal,' i. (1881) pp. 230–1 (5 figs.).

† See this Journal, iii. (1880) pp. 1076–8.

FIG. 113.

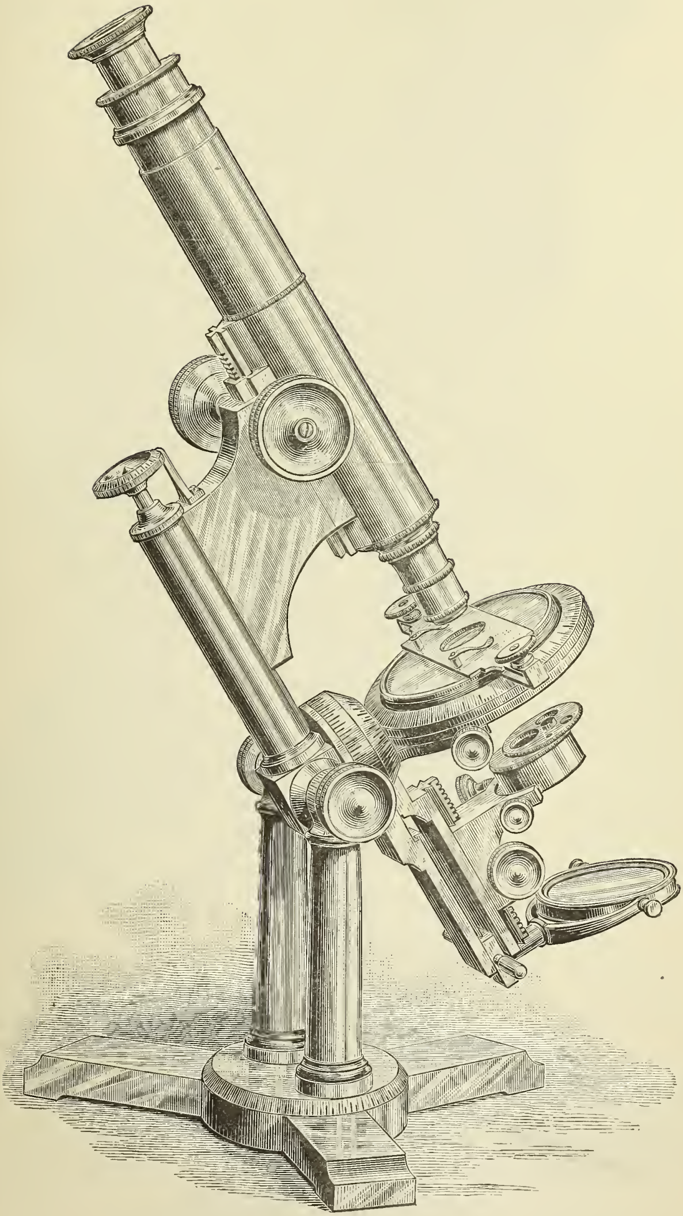
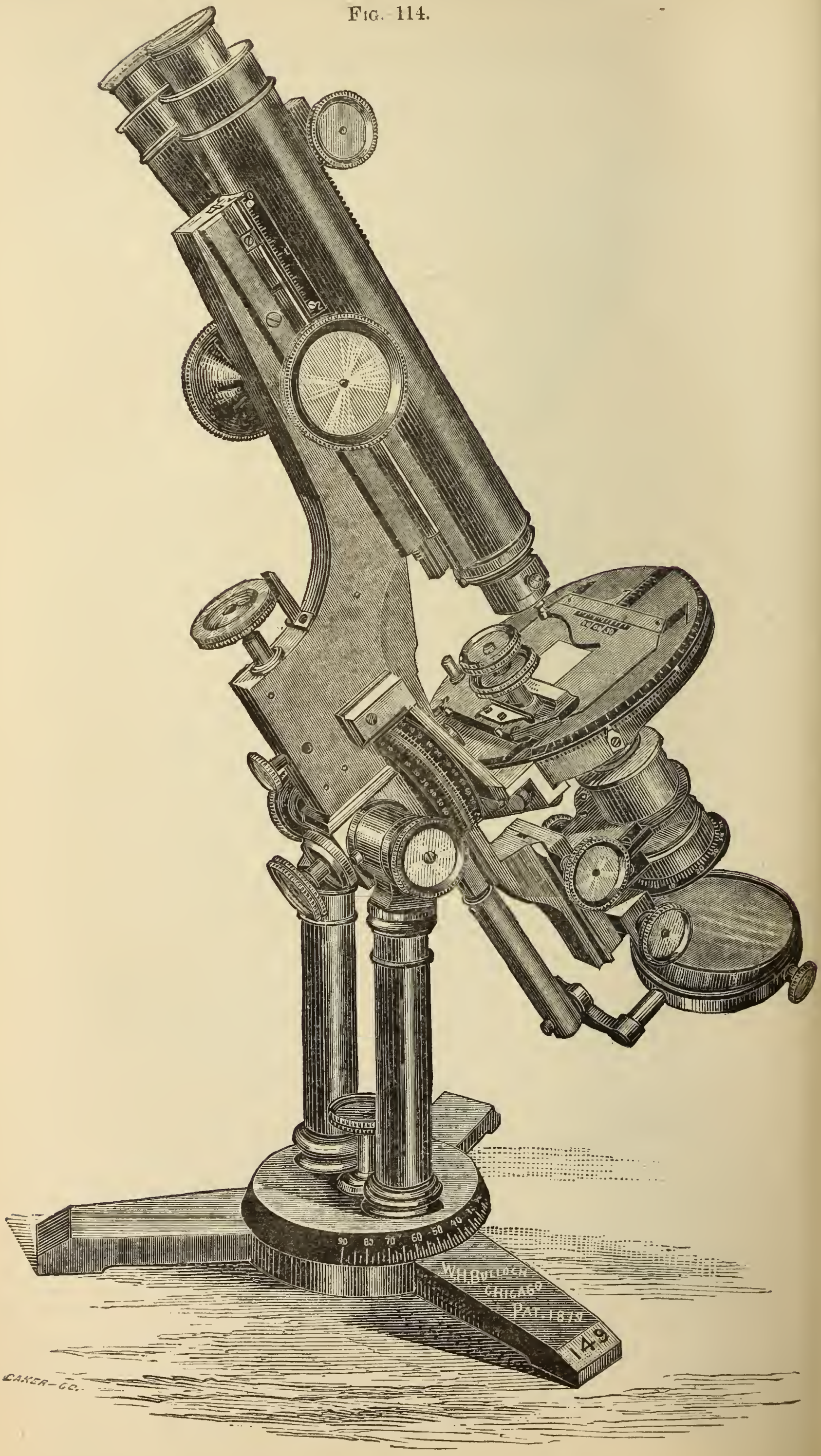
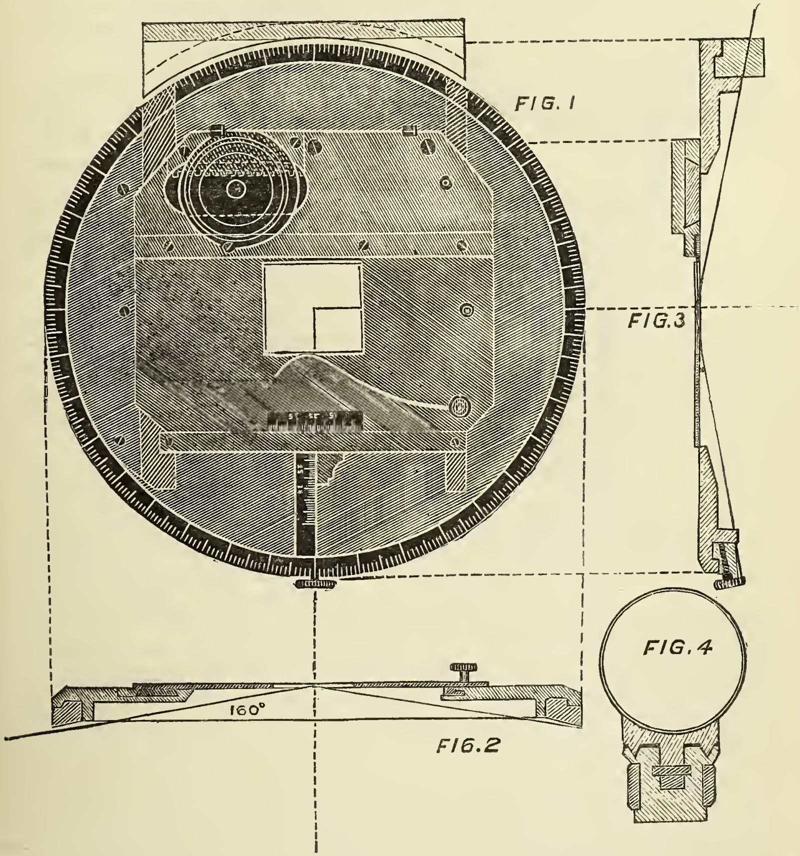


Fig. 114.



this motion; they work one through the other, and act upon racks placed at right angles. Scales placed at right angles serve as finders.

Fig. 115.



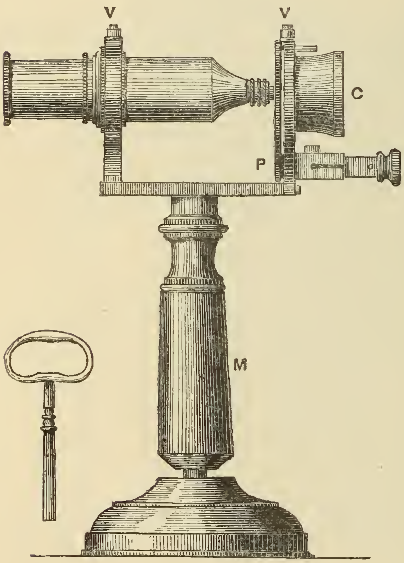
The substage is similar in design to that of Messrs. Sidle, described *ante*, p. 555, and a screw has been added to the base for clamping the base-plate which rotates on the tripod.

Guillemare's School Microscope.*—This (Fig. 116, $\frac{1}{3}$ nat. size) is the design of Professor A. Guillemare, of the Lycée Charlemagne, Paris, and is apparently intended for junior pupils, its speciality being the screws V and V, by which both the tube and the slide are locked, so that they can only be freed by the professor with the aid of the key shown in the woodcut.

* Journ. de Microgr., vi. (1882) pp. 233–5 (1 fig.).

The handle M, by which the instrument is held when passed round a class, is hollow, so that it can be placed on a vertical support, if desired. C is a metal cone polished inside, and we gather that at P is the arrangement for fine focussing after the tube has been adjusted as nearly as possible and locked.

Fig. 116.



Gundlach's College Microscope.—This Microscope, till now called the "Physician's Microscope No. 1," is shown in Fig. 117. Its speciality consists in the *adjustments*, of which there are four, thus described (from the maker's catalogue):—

"(1) A rack-and-pinion movement; (2) a sliding adjustment of the body; (3) a micrometer-screw, and (4) a combination of micrometer-screws giving a slower motion than has ever been brought into use before. The racks and pinions are cut with some new and original tools and with the greatest exactness.

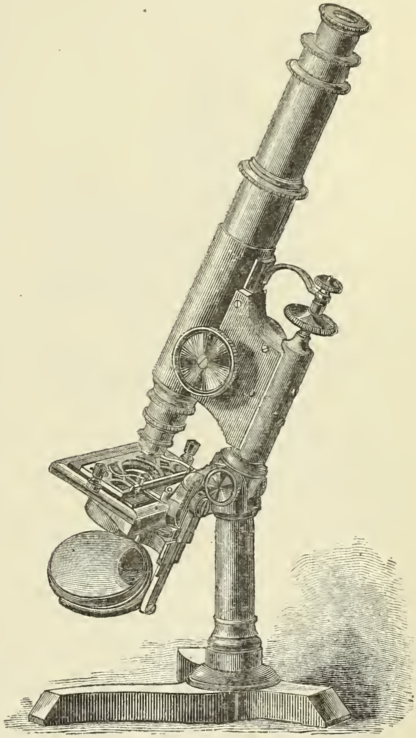
"Gundlach was the first to think of the advantages of the combination of the sliding adjustment with the rack and pinion, and to bring out a series of Microscopes on this plan. The former allows the body to be removed for changing objectives; and, by combining the two, the body may be made to stand so high that first-class low-power objectives may be used on these stands. Lower powers may be used on them than most large stands will allow.

"The ordinary fine adjustment is by micrometer-screw acting on Gundlach's new frictionless roller motion, patented in 1879. This motion is free from the fault of displacement of the optical axis, from so-called loss of motion, and from lateral motion, while it has twice the old extent of motion. . . . .

"In working high powers, microscopists have felt the need in some work of a slower motion than that of the ordinary micrometer-screw, which cannot be made much finer and still be durable enough. This need is now supplied by the combination of two screws which give a resultant motion equal to the difference in the threads employed. One of these screws is a little coarser than the ordinary micrometer-screw, and may be used alone as a fine adjustment, and a change can be made instantly from this to the finer motion. Either motion is given by one milled head next to the top of the pillar, and the change is made by turning a smaller clamping screw having its head over the

fine adjustment screw. By tightening the clamping screw, the adjustment is in order for the work of the combination; by loosening, for that of the coarser screw only. As the thread of this is a very little coarser than the ordinary micrometer-screw, it alone gives a better motion for medium powers than the fine adjustment in common use, a second advantage of the invention. The combination of screws in use on these Microscopes gives a motion equivalent to that of a screw having three hundred and sixty threads to the inch. Any desired combination can be made."

FIG. 117.



The *stage* consists of a strong, polished glass plate, made secure by a brass frame, which is nickel-plated. The glass plate has a hole in the centre, and is ground to permit the greatest obliquity of light. A new object-carrier, consisting of an ornamented brass frame, with a rest for the object - slide, removable clips, and two handles, moves with evenness upon the stage, to which it is pressed by lever springs, with double joint, to permit motion in every direction, and from which it is kept by frictionless pins that do not scratch the stage. The whole carrier can be removed and its place supplied with spring clips.

The *substage* slides along the mirror-bar, thus keeping the diaphragm or other accessory concentrically with the mirror upon the object with central as well as oblique illumination. It can be removed without interfering with the mirror.

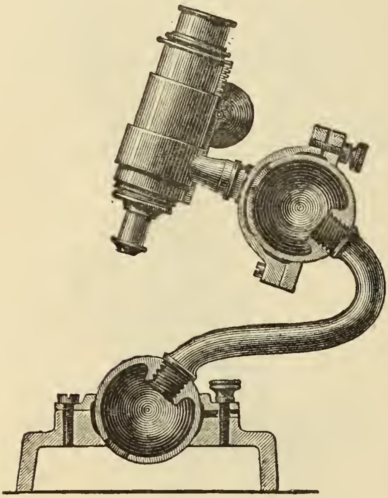
The *diaphragm* is of novel construction, and is fitted to the substage. It is of such form that it can be brought close to the slide, and its openings brought in use without changing its position on the mirror-bar.

The *mirror-bar* swings to an angle of 45° above the plane of the object, allowing the mirror to be used as a condenser on opaque objects. The mirrors have their centre of motion around the point where the optical axis intersects the plane of the object.

Martens' Ball-jointed Microscope.*—This (Fig. 118) is the invention (patented) of A. Martens, of Berlin, and is thus described :—

In the observation of metals in their microscopical relations it is desirable to be able to give the Microscope the greatest possible power of movement, since the objects for the most part do not admit of small fragments being taken from them. A Microscope was originally made for the author by Zeiss, in which movability of the stand was obtained by three hinge-joints, which could be clamped up by a screw so that the tube remained quite firm at every angle ; indeed it was firm enough to admit of a fine adjustment being used. It was, however, too limited in its action, it worked properly only in a line perpendicular to the object, and in order to examine the neighbouring parts either the heavy object or the equally heavy instrument had to be moved.

Fig. 118.



In the new construction the inventor has obtained far greater movability. Instead of the hinges, ball-joints of large diameter are made use of, the balls being hollow and clamped between two annular plates, placed unsymmetrically with regard to the centre of the ball. The plates are forced together by the action of a screw, a strong spring between them separating them again when the pressure of the screw is slackened. Thus a clamp, firm but readily loosened, is obtained. One or more ball-joints can be used for each stand.

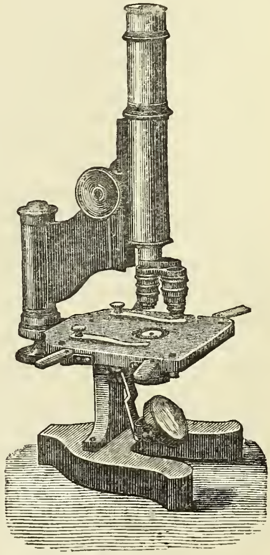
Polarizing Microscopes.†—Prof. J. B. Listing objects to the term "polarizing Microscope," so commonly applied to the Nörremberg (or Hofmann) polarizing apparatus. The use of the name "Microscope" is not only incorrect in itself but it conflicts with that which properly belongs to a Microscope by means of which small objects are examined by polarized light, such as sections of minerals, crystals, hairs, muscle-fibres, &c. The objective of the true polarizing Microscope retains its ordinary dioptrical function, but in the other case no question of amplification comes into consideration (but rather a large angular diminution), the instrument without the lower collecting-lens being in reality an inverted astronomical telescope with the eye-piece turned to the object.

* Zeitschr. f. Instrumentenk., ii. (1882) p. 112 (1 fig.).

† Bericht wiss. Apparate Lond. Internat. Ausstellung im Jahre 1876 (A. W. Hofmann, 1878–81) pp. 367–8.

Schieck's Microscope with Large Stage.*—Prof. G. Fritsch writes that F. W. Schieck deserves special commendation "for constructing stands which, in regard to the size of the stage, very considerably exceed the ordinary dimensions without being either clumsy or unsightly. The ever increasing necessity for examining preparations of large size (such as sections of brain), or series of preparations on large slides, make such stages a pressing necessity." Fig. 119 shows one of these stands with a stage 14 cm. wide. To prevent the slide from falling over the sides when moved to the furthest extent, two arms are attached to each side, the upper surface of which is on a level with the stage. When not required they can be turned back close to the sides of the stage.

Fig. 119.



Projection-Microscopes.†—Dr. Hugo Schröder, in an interesting paper on lantern or projection-Microscopes, points out that the oldest forms originated in the earliest times of microscopical observation, when the whole magnifying apparatus consisted of a simple bi-convex lens with very small aperture. In consequence, the images had great depth, so that relatively thick objects were shown with distinctness. The images, however, by lamplight were exceedingly dim, if the power amounted to 100 or more. This was not, however, the only defect arising from the very small aperture, for the resolving power was also very insignificant, and the image was injuriously affected by the chromatic and spherical aberrations of the objective-lenses. As the result of these and other defects, the instrument was so unsatisfactory with regard to distinctness of detail that the same objective-lens was more efficient when used as a simple magnifying-glass.

It will therefore be naturally asked in what consists the usefulness of the projection-Microscope?

Its utility is to be sought in quite another direction, and under certain circumstances it becomes highly important, if not indispensable. For purposes of demonstration there is nothing better than a good projection-Microscope. Many persons can examine the object at the same time, and a larger field of view can be obtained than would be possible with any other combination. The angle of the image, which in the compound Microscope is at most 10°, can be increased to

* Bericht wiss. Instrumente Berliner Gewerbeausstellung im Jahre 1879 (L. Loewenberg, 1880) p. 293 (1 fig.).

† Central-Ztg. f. Opt. u. Mech., iii. (1882) pp. 2–4, 15–17 (1 fig.).

40° or even to 60°, whereby, under equal circumstances, a 36-times larger surface can be viewed, and by 100 and more spectators. It is also very useful for pointing out to beginners particular parts of the object, in the same way as a drawing would be explained. The observation of the projected image requires no especial practice, as in the compound Microscope; and finally the image can be easily drawn or even photographed.

Notwithstanding all these advantages, however, these instruments —called by Professor Petzval the "*chef-d'œuvre* of optical art"—have hitherto been very hardly treated. Usually the lenses of a compound, Microscope (often most unsuitable) were employed, and illuminating lenses with surfaces exactly convex, thus constituting a very indifferent instrument. The necessity of employing a heliostat, and the difficulty of always obtaining sunlight at the required moment, gave an impulse to the construction of the so-called lantern Microscope used only with artificial light, and in the last century Adams was celebrated for such instruments, which could be used in several ways, as simple, compound or lantern Microscopes. Their performance was best as simple, moderately so as compound, and very inefficiently as lantern Microscopes.

Much later, when achromatic objectives were introduced, Chevalier in Paris and Duboscque constructed much more complete instruments, and in modern times Foucault invented the excellent photo-electric projection-Microscope.

At first sight nothing seems simpler than to construct a good lantern Microscope since we have only to replace sunlight by lamplight. This is, however, not the case, for on further consideration it will be found that the conditions which are so favourable with sunlight cannot be maintained with any artificial light—we can only approximate to them. The intensity of all artificial illumination, even the strongest electric light, is considerably less than that of the sun; besides, all strong lights have far too large an illuminating surface to give distinct images with many fine details. The earlier lantern Microscopes had the worst possible illumination, for good oil-lamps did not then exist. If petroleum or gas lamps be used, it will soon be found that the magnitude of the flame in no way heightens the effect; although the image surface may appear to be more brightly illuminated, the contrast between the light and dark parts will be less—the absolute intensity is greater, but the relative smaller. If we follow the course of the illuminating rays it will be seen that the flame limits light diverging in all directions. Divergent light cannot, however, be employed for the illumination of an object, but we must always have convergent light. The source of light is therefore placed in the first focal point of a convex illuminating lens and the object in the second. The nearer a lens of given diameter is to the source of light, the greater will be the aperture-angle of the illumination; the greater the quantity of light utilized the further off will be the second focal point and the less the convergence of the rays upon the object. The convergence of these rays must, however, correspond with the final convergence of those which limit the field of view, and therefore, for all the rays falling on

the first illuminating lens to be utilized, a second condition must be fulfilled, viz. that the image of the source of light which falls on the object must not be larger than the object itself. Since the source of light and its image are as the two focal lengths it is obvious that these conditions can only be strictly fulfilled with very low powers and under very favourable conditions. With higher powers the greater part of the light is lost for this reason, that the intensity of the light with the higher powers diminishes not with the second, but approximately with the third power of the amplification.

The greater part of the light from the lamp does not fall on the first illuminating lens. In order to utilize as much of this portion as is possible the attempt has been made to concentrate by means of large concave mirrors the light which is lost on the side opposite to the condensing lenses. The mirror—which should be concave—must have the flame in its centre of curvature, the image of the flame, therefore, coinciding with the flame itself. As this is transparent, only a small portion is lost by absorption, and the part that is utilized follows the same direction as the other rays. This condition is absolutely necessary, in order to avoid light-nodes in the illuminating cone produced by two different converging rays, whereby the clearness of the image is materially affected. It is thus evident that with all ordinary flames only the segment of a small circular surface is utilized. The flat flames, the narrow edge of which is used (as for example in the Sciopticon), give the best results. On account of the too great extent of the illuminating surface, lighthouse lamps, which consist of a number of concentric wicks, only yield a very moderate result, notwithstanding the quantity and intensity of their light. Fresnel's ring-lenses are also unsuitable. Illuminating lenses of the smallest dimensions and the largest aperture angle (as near as the temperature of the flame will allow) give the best results. It is also advisable to insert a movable lens between the object and the illuminating system, in order to regulate the convergence of the light according to the requirements of the objective employed. To obtain a perfectly uniform illumination of the image-surface it is further necessary that it should not be the image of the source of light produced by the illuminating lens that falls on the object, but a neighbouring aberration-circle, in which the light is uniformly distributed. (Petzval has already drawn attention to this.)

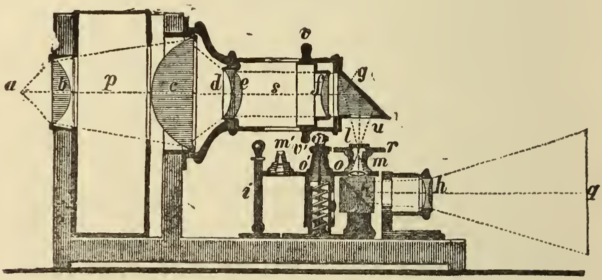
Besides lamplight the Drummond lime-light has been employed very satisfactorily, and after many experiments Dr. Schröder considers it the best on account of the small and intensely illuminating surface of the lime and its pleasant light. In spite of its intensity, the magnesium-light gives no satisfactory result, because it does not burn steadily, and even when a ventilator is employed, the lenses are covered with the burnt magnesium. The electric light is excellent on account of its large intensity in a small space, but its unsteadiness is objectionable. The Jablochkow candle is most suitable, notwithstanding its small intensity, if a uniform height can be maintained. The incandescent light is too small in intensity, and too oblong.

If in course of time the electric light is more perfected a new epoch will commence for the lantern Microscope, and this highly interesting instrument, in a compendious form, will certainly not be wanting in any wealthy (*gebildeten*) family.

The objectives must of course be as free as possible from spherical and chromatic aberration, and must form a perfect image of the object, not only in and near to the axis (as in the ordinary compound Microscope), but over the whole extent of the image-surface, a by no means easy matter with large apertures.

Dr. Schröder has constructed a projection-Microscope for the Microscopical Aquarium at Berlin, and a considerably more improved one for North America, the first of which is shown in Fig. 120.

FIG. 120.



The source of light is at a; b and c are plano-convex lenses of crown glass, between which at p an alum cell is interposed to intercept the heat rays. The rays emerge from c strongly convergent, but are made parallel and corrected for spherical and chromatic aberration by the combination $d\,e$. The parallel beam s is made convergent by the movable lens f according to the requirements of the field of view. For polarized light a large Nicol prism can be placed at s, and selenite plates at u. The analyser is attached to the objective.

By means of a silver prism g the illuminating beam is thrown upon the object l vertically "in order to admit of using receptacles for holding living animals in fluid, &c."

The objectives m, m' are attached to a revolving holder o, o'. Powers from 100 to 2000 can be used. They are focussed by the screw n, the upright piece t serving for revolving the holder when a different power is required.

The rays after having passed through the objective are reflected by a silvered prism h horizontally through the negative achromatic lens h', and form an image at q.

The American instrument has immersion lenses giving a power of 4000 times, and can be used for opaque objects by means of a large Lieberkuhn.

"Notwithstanding the many reflecting surfaces," Dr. Schröder says that "with only an *ordinary petroleum lamp* the larger diatoms such as *Triceratium favus* can be very distinctly seen. With the oxy-

hydrogen light living diatoms and sections of plants are extraordinarily beautiful, all natural colours appearing very bright. With a power of 2000 the cornea of a fly occupies the entire field of view, and the fine vitreous membrane in each cell is seen magnificently."

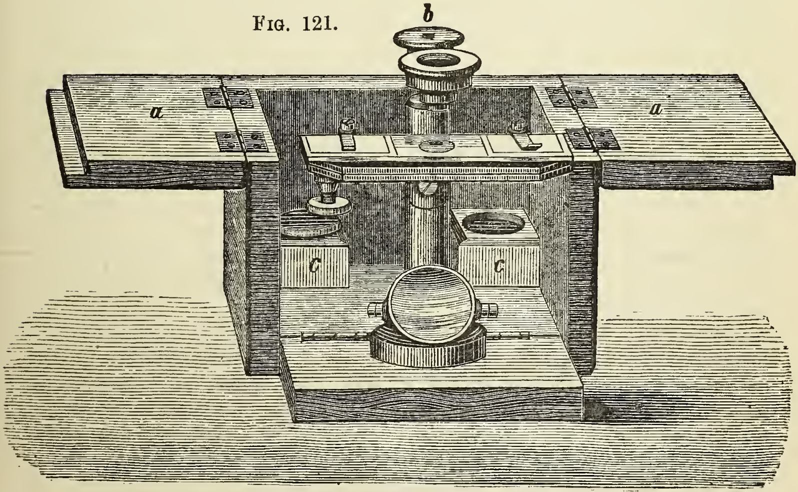
Rock-sections can also be well shown in polarized light.

Apparatus for Projecting an Image to any required Distance with Variable Amplification.*—For lectures it is often desired to throw on the screen an image of an object with a given amplification, and in order to vary the amplification, several auxiliary appliances have hitherto been brought into requisition. A. Crova has devised a means by which, with the same distance of the object from the screen, the amplification may be changed with the aid of only one additional piece of apparatus.

He places between the object and the screen two lenses of equal focus, one plano-convex and the other plano-concave, their distance apart being capable of being altered as required. The plano-convex lens is fixed in a frame which is fastened to a horizontal brass rod resting on the stand, and along this rod the other lens (similarly fixed in a frame) is made to move by rack and pinion. The lenses have a focus of 0·15. By means of divisions marked on the rod the lenses can be set at the distance required; when the plano-concave lens is at zero the two lenses are completely in contact, and their optical centres coincide; according to the distance between the lenses the converging or diverging effect of the system predominates.

Waechter's Travelling Dissecting Microscope.†—This, Fig. 121,

Fig. 121.



* Journ. de Physique, 1881, p. 159 (1 fig.)

† Bericht wiss. Instrumente Berliner Gewerbeausstellung im Jahre 1879 (L. Loewenberg, 1880) p. 302 (1 fig.).

by P. Waechter, of Berlin, is specially adapted for travelling, as when closed, it forms a box of only 10 cm. in length by 10 cm. in breadth and 7 cm. in height. The two halves of the cover *a*, opening right and left, serve as supports for the hand. Inside the box is the stand *b* with the stage and mirror, as well as the receptacles *c* for keeping the three achromatic objectives of 15, 25, and 40 power. The remaining space can be utilized for other apparatus.

Measurement of the Power of Eye-pieces.*—Dr. Royston-Pigott originally suggested the placing of the eye-piece in the sub-stage and throwing an image of a rule, supported at a distance of 10 inches from the diaphragm of the eye-piece, upon a stage micrometer. Mr. W. H. Bulloch having found considerable difficulty in getting the lines of the rule sharply defined, has devised an apparatus consisting of an ordinary Microscope with an objective of 2 inches focus, used to examine an image of a diaphragm, formed by the eye-piece to be measured. The exact size of the diaphragm and its distance from the eye-piece being known, the size of the miniature image formed by the eye-piece can be readily measured, and a simple calculation then gives the magnifying power.

Hall's Eye-protector for use with the Monocular Microscope.†—Dr. L. B. Hall describes an appliance to be used with the monocular instrument, for the purpose of protecting the unemployed eye, pointing out that the employment of one and the same eye at the tube of an optical instrument is the same practice that cost the squinting eye of childhood its power of vision. So many of us are contented at having trained one eye to do acceptable work, that we think we cannot spare the time to discipline the other. If this process ended when the head is withdrawn from the instrument, the practice would be less dangerous, but the trained eye finding an unequal companion, performs reading and all other near work with greater ease than its fellow; sees so much more distinctly that the other is left without exercise, except for large objects, and becomes of less and less value as the process goes on. Dr. Hall could point, he says, to those who have practically lost one eye by this process, and estimates that one-half of all those who have used the monocular Microscope to any considerable extent during five years are monocular men for all fine work, meaning by this that every such person who can "resolve" one of the more difficult tests with one eye will find himself unable to do so with the other.

How often have we heard persons exclaim, upon looking into a binocular Microscope for the first time, how much easier it is to see with the instrument, and this with one field quite dark; such expressions are not to be ascribed wholly to dissimulation or flattery, and for the following reasons, viz.:—When both eyes are left open and one is applied to an instrument, the two images, being unlike,

* Amer. Mon. Micr. Journ., iii. (1882) pp. 103–4 (1 fig.). 'The Microscope,' ii. (1882) pp. 83–4.

† 'The Microscope,' ii. (1882) pp. 88–90 (from the 'Medical and Surgical Reporter').

confuse each other in the natural endeavour to blend them. This requires a mental effort to exclude the impression upon the retina of one eye and regard that upon the other only. Again, when we close one eye by contraction of the orbicular muscle, or by pressure, as by the hand, we cause contraction of the accommodating muscle also, and of the other eye as well.

To facilitate the training of both eyes the following eye-protector is proposed. It consists of a small, opaque disk near the eye, supported by a wire extending from its outer edge downward, to a point on the tube low enough to be out of the way of the nose, then bent upward, parallel to the tube, but not touching it, and attached to a ring near the top. Dr. Hall's is made of a piece of brass wire, No. 18, about 45 cm. long; a loop at one end, 4 cm. in diameter, covered with a piece of black paper folded over and gummed down, forms the disk. At the other end is a ring to fit the draw-tube, and then the intermediate wire bent. It is attached below the flange, on the draw-tube, where there is no lacquer to be scratched, but if it should be thought desirable to attach it above the flange, then the ring ought to be covered with chamois, so as not to wear the polish.

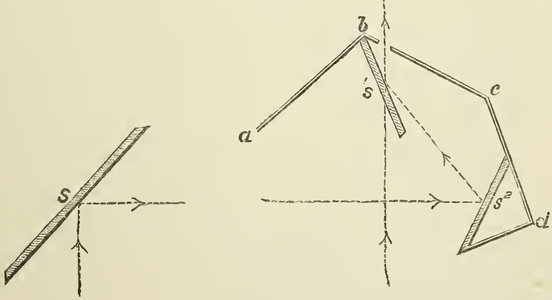
The advantages of this form are, the small size of the disk and its support, interfering with the working of the instrument and view of the stage as little as possible. The support is not in the way of the nose; it is elastic, not uncomfortable when touched by the nose, and striking it does not displace the stand; it can be rotated about the tube and used with either eye alternately; it can be easily adjusted to the eye-distance of any worker; and, lastly, it is of so simple a construction that any one can make it for himself at a very small cost.

Cramer's Camera Lucida* (also Hofmann's and Oberhäuser's).—Dr. C. Cramer can only concur to a small extent in the warm praise which Dr. H. von Heurck has bestowed upon Hofmann's camera lucida.† Besides the advantage of having the paper lie

* Bot. Centralbl., vii. (1881) pp. 385–91 (2 figs.).

† Hofmann's camera lucida was described and figured in this Journal, ii.

FIG. 122.



(1879) p. 21. We, however, add here a diagram of it (Fig. 122), S being the silvered mirror over the microscope-tube, s^2 the smaller silvered mirror which

Fig. 123.

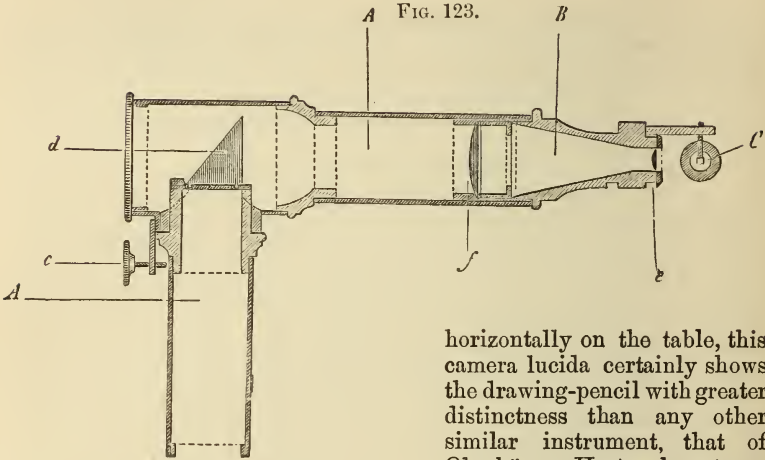
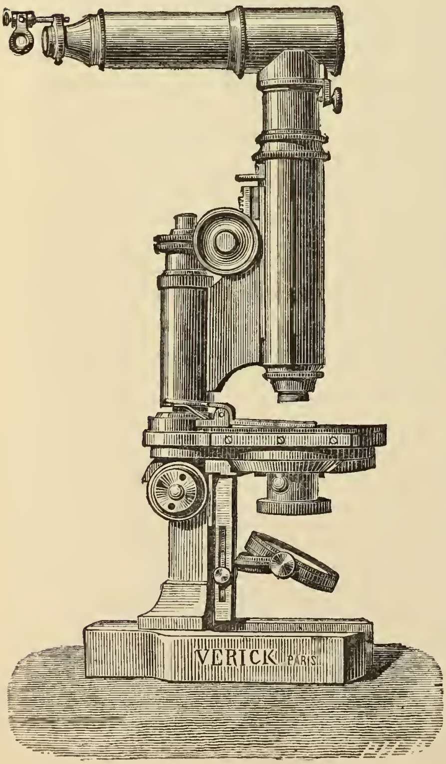


Fig. 124.



horizontally on the table, this camera lucida certainly shows the drawing-pencil with greater distinctness than any other similar instrument, that of Oberhäuser-Hartnack not excepted. For very long-sighted persons the two convex glasses placed below the two smaller mirrors may be of use, but for normal and short-sighted persons they are useless, and it is, moreover, better left to each individual to assist his sight by spectacles as required. The cap (with an aperture) over the two mirrors is also well adapted to serve as a guide to direct the eye of the observer, and thus facilitates its use by beginners, who often have a difficulty in finding the image. These advantages are, how-

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receives the rays from S and reflects them upon a plate of glass s^1 and thence to the eye, the pencil being seen through the latter (*a b c d* is the fitting which holds s^1 and s^2). There is a subsidiary apparatus formed of two plano-convex lenses for reducing the amplification.

Oberhäuser's (or Hartnack's) camera is shown in Figs. 123 and 124. It consists of two tubes A A at right angles, a rectangular prism *d* being inserted at the point of junction, by which the rays coming from the object are reflected through an eye-piece B *f e* to a smaller prism C, and thence upwards to the eye.

ever, counterbalanced by considerable defects. The sharpness of the image is impaired by the threefold reflection, which is effected partly by mirrors silvered at the back, and partly by the transparent mirror, the two surfaces of which produce images which of course do not coincide. By using still thinner mirrors this defect might be lessened but not removed entirely. The right and left sides of the object are inverted (though the image is otherwise erect), and this renders it difficult to a most tiresome degree for the microscopist, who is accustomed to the inverted motion of the object, to adjust it, and still more to afterwards correct complicated drawings by the ordinary microscopical image. Employing an orthoscopic eye-piece or inverting the drawing arrangements is of no use, as the microscopical image, compared with the drawing projected by the camera, appears in both cases with right and left hand parts interchanged.

The camera, moreover, will not bear the application of the blue glass disks supplied with the Oberhäuser instrument for modifying the light, as the image becomes almost invisible. As its characteristic, however, is the relatively great brightness of the surface of the paper, a smoked glass mirror, in place of the plain one s^1, would be the more serviceable arrangement, but the instrument is not constructed so as to allow such a change to be readily made.

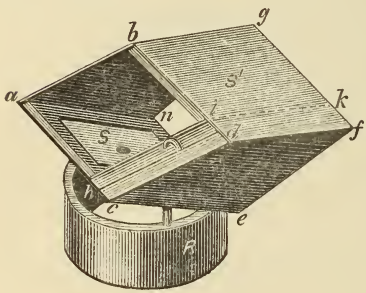
The combination of lenses for the purpose of reducing the image is, the author thinks, a valuable addition. The insertion of the camera lucida is of course equivalent to lengthening the tube of the Microscope, and the image is strongly magnified, often too much so. It is only to be regretted that when both plano-convex lenses are employed simultaneously, the image, already obscure, becomes still less clear, and in some cases almost invisible. Dr. Cramer also draws attention to the fact, not thought of by Hofmann himself, that his camera lucida combined with the reducing apparatus, when inserted in the tube of the Microscope instead of the eye-piece, will give an image without the objective. The amplification with the two lenses is about four times. He considers that "if Hartnack could prevail upon himself to construct his camera lucida in such a way that in the short arm, or in place of it, a combination of lenses analogous to Hofmann's were introduced so that an image magnified only four to eight times could be obtained, the value of this instrument, already so desirable for the microscopist, would be materially increased."

Dr. Cramer then describes an instrument suggested by himself:—
"Those who use the Microscope, especially beginners, are not always in a position to buy a camera lucida. I think, therefore, that I shall be doing many a service by showing how any one who possesses a little mechanical dexterity may make for himself the very serviceable camera lucida shown in Fig. 125.

"It consists essentially of two somewhat diverging mirrors, one of which, S, allows the image of the object to be viewed direct through a circular hole made by removing the quicksilver from the under side of the mirror. By the second mirror, S′, the rays from the pencil and

paper, which lies horizontally on the table to the right, are reflected to S, and thence upwards to the observer's eye. If the field of view is too bright, the light may be moderated by blue glasses placed in front of the illuminating mirror. The apparatus is attached by a wire pin to a ring R, made out of strips of paper, and can be readily detached when required.

Fig. 125.



"The ring should be made first, as it has to move with some friction on the upper end of the tube of the Microscope, and must exceed in diameter the upper rim of the eye-piece about 2‴. The eye-piece should be removed, and the upper end of the tube used as a mould for making the ring. The outer layers of the ring must be made higher than the inner ones by about the thickness of the upper rim of the eye-piece. This rim will thus fit into a corresponding depression in the ring. The aperture for receiving the wire pin is best made last of all, by the repeated insertion of a red-hot needle. This should be done with the eye-piece in place in the ring. After this, two rectangular plates should be cut out of an old mirror, the glass of which must not be too thick, and the coating of quicksilver should be scratched off from a central hole. Then attach by gum two pieces of card of the same shape and size to slightly larger pieces of note paper, and place the mirrors (after making a hole in one of the cards to correspond with that in S) with their backs downwards on the cards. Gum the projecting edges of note paper, turn them up, and press them down over the edges. Then make the trapezoid sides of the apparatus (also out of cardboard), and attach them to larger pieces of note paper so as afterwards to be able to glue them firmly to the backs of the mirrors. Cut two pieces the exact shape of one of the sides out of a cigar box for the purpose of strengthening the side turned towards the observer, which receives the wire pin. A pin of about 1 mm. thickness is quite sufficient. It should be bent twice at right angles, so that its two legs of unequal length are about the thickness of one of the two wooden boards apart. The longest leg passes between the card and one of the boards, and the other shorter one between the two boards which are to be glued together. Grooves must first be made in the boards corresponding to the thickness of the wire. The direction of these is easily settled by remembering that the pin must be placed exactly in the middle of the half of the ring turned towards the observer. The sides *a b c d* must be in a horizontal plane, and the lower edge *e n* of the mirror S (parallel to *a c*) must be exactly on the boundary between the lower and upper halves of the card ring.

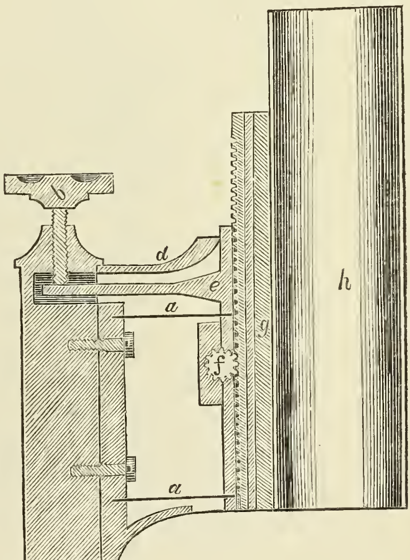
"When all has been put together, it is well to increase the firmness

of the apparatus by pasting on an additional piece of card of the shape *b d f g*, and all the surfaces except the mirror should be blackened with indian ink.

"Dimensions:—*a b* and *c d*, also *a h*, *b i*, *g k* = 30 mm.; *b g*, *d f*, and the corresponding sides of S = 37 mm.; the mirror less by the thickness of the card—*h c*, *i d*, and *k f* (in my apparatus made for Oberhäuser's eye-piece = 10 mm.) will vary according to the size of the eye-piece. Diameter of the hole in the mirror S = 3 mm. Distance of its upper edge from the left side of the mirror = 19 mm., angle *f d c* = 157°, *d c e* = 36°, *c e f* = 130°, *e f d* = 37°."

Bausch and Lomb Optical Co.'s Fine Adjustment.* — Fig. 126 represents the original of the fine-adjustment referred to at Vol. I. (1881) p. 110. Two strong parallel blades of finely tempered steel, *a a*, are securely fastened on one end to the back of case *d*, on the other to the arm *e*, which carries the rack and pinion. *b* shows the micrometer screw, which is fitted to the upper part of the upright arm *c*, *f* is the pinion, *g* the rack and slide, *h* the tube. Two screws fasten the adjustment case *d* to the pillar *c*. An arm projects from the part *e* and passes into a recess in the pillar *c*. The springs support the entire body, and as their tension is upward, the projecting arm bears continually against the micrometer screw *b*, and it is evident that the distance traversed by the screw involves the same movement of the arm *e*, and consequently the body. The only points of contact are at the ends of the springs *a*, *a*, where they are fastened respectively at *d* and *e*, and on the micrometer screw, and as in the former there is absolutely no friction, there is no wear; while that which may eventually take place in the latter is taken up by the force of the springs.

Fig. 126.



The points of excellence claimed by the makers for this adjustment over all others, are the following:—

* From the Company's Price List, 7th ed., 1882, pp. 4–5 (1 fig.).

"1. It moves the entire body. 2. It is extremely sensitive and direct. 3. It has no lateral motion or displacement of the image, while adjusting. 4. It has absolutely no lost motion. 5. It can in no manner deteriorate." The "Professional" Microscope (shown at

Fig. 127.

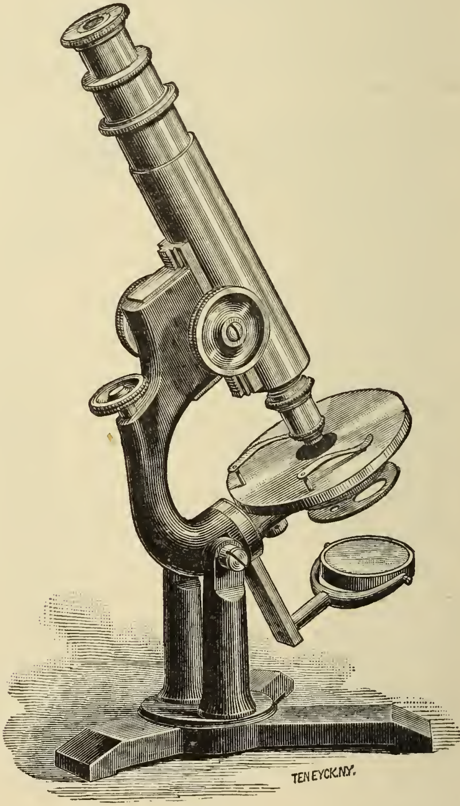


Fig. 113, p. 667) has the fine adjustment in the form above described, while in the "Model" Microscope of the same makers (Fig. 127) a slight variation is made by the bar *e* being placed below instead of above.

Nose-piece for Binocular Prisms.—When the broad gauge ($1\frac{1}{4}$ in.) screw is used (for low powers of wide angle), it is necessary to provide some means, not merely for the withdrawal of the prisms of the binocular, but for the removal of its fittings so that the end of the tube may be left quite free for the full diameter of the objective.

This is perhaps best accomplished by the prism and its fittings being in a separate nose-piece, attached to the tube by a well-made

bayonet catch, when it can be detached as required. By screwing into the broad-gauge thread, after the binocular fitting is removed, an adapter with Society screw, objectives of wide angle, but not requiring the broad screw, can also be used without their being handicapped by the fitting.

This plan, by which there are in fact three distinct arrangements —1st, the broad-gauge screw; 2nd, the Society screw without the binocular; and 3rd, the Society screw with the binocular—is the one adopted by Messrs. Sidle in the "Acme No. 2" Microscope.*

Homogeneous and Water-immersion Objectives.†—"Akakia," replying to an inquiry whether homogeneous-immersion objectives are to be regarded as useful only where apertures greater than the limit for water (1·33 N.A.) are required, says that "experience has demonstrated that all incident pencils from one refracting medium to another of much greater refracting power, beyond the cone 140° in the rarer medium, make unfavourable angles—angles that cannot be effectually dealt with, and this applies the more the greater the difference between the media. For instance, in a strictly dry lens the aperture between the cone 140° in air (·94 N.A.) and 180° (1·0 N.A.) is practically of little use; in a water-immersion lens the cone between 140° in water (1·25 N.A.) and 180° (1·33 N.A.) is likewise of but little service; and equally in a homogeneous-immersion lens the cone between 140° in the immersion fluid (1·43 N.A.) and 180° (1·52 N.A.) is practically useless. Professor Abbe has arrived at the conclusion that the limit of useful aperture is a much lower figure than 1·43 N.A. [Not so. He considers 1·45 the practical limit, *ante*, p. 472—Ed.] With our present means of construction, however, the lenses which exhibit the finest definition with direct oblique illumination that would utilize 1·25 N.A. are not those lenses of precisely 1·25 N.A., but of higher aperture. It would thus appear that in order to get a well-corrected outer zone of 1·25 N.A., the lens must really have a larger aperture to cope successfully with the difficulties of the marginal aberrations. It should be observed that by the homogeneous-immersion formula, the higher apertures (say those beyond ·94 N.A.) are more successfully corrected, because the path of the rays is more regular, and can thus be more definitely calculated. This is clearly evidenced by the superiority of definition seen with homogeneous-immersion lenses, when, by the conditions of the object and the illumination, the effective aperture is reduced well within the limits that have already been attained by the water-immersion formula: it is then seen that for all apertures greater than 1·0 N.A. the homogeneous-immersion formula is to be preferred. I believe it is now generally accepted among expert manipulators that the water-immersion formula has seen its best days, and the time is not far distant when it will be entirely superseded."

Collar Correction of Objectives.‡—Prof. A. Y. Moore considers that collar correction has not received the attention which it deserves,

* See also Bulloch's Congress Microscope, this Journal, iii. (1880) p. 1076.
† Engl. Mech., xxxv. (1882) p. 551.
‡ 'The Microscope,' ii. (1882) pp. 8–11.

being overlooked entirely among the younger microscopists. As so little has been written on the subject, he gives "a few simple directions.

Every objective has a certain colour with which it shows best, and there is probably no object better adapted to the purpose of determining this colour than a well-marked *Podura*-scale. . . . . When a good scale is once obtained, great care should be taken to keep it dry, for when wet it is of no use.

Now, by examining this scale with a first-class $\frac{1}{4}$ or higher power of medium or wide aperture, it will be seen that the 'exclamation marks' are more or less coloured. Pay no attention to this at first, but carefully turn the collar back and forth until the marks appear sharpest and smallest. That will be the point of best correction, and now the colour of the markings should be noticed. Having carefully determined the exact tint of best correction, throw the objective a little out of proper adjustment by turning the collar towards open point or zero. This over-corrects it, and at the same time notice the change in colour. The markings seem to expand, becoming hazy and not at all sharp. Now turn the collar towards closed until the point of best correction is passed: here the same thing is seen in regard to expansion and haziness, but a different tint seems to make its appearance. By attending very closely to this colour (which is the secondary spectrum), the proper correction can easily be made. I can best illustrate this by the following trial:—

I have before me a $\frac{1}{15}$ objective. By trial over a *Podura*-scale I find that when best adjusted the marks appear of a brilliant ruby red (and most of the finest objectives which I have seen show best with this colour); by turning the collar below zero they turn greenish, while, if turned towards closed, they become pink. Hence at the first trial of any such object, should it appear green, the collar should be turned towards closed until the ruby tint appears, and if too pale a red, or pink, the collar should be turned towards zero. By a little practice the microscopist can tell at a glance which way to turn the collar.

There are some objects on which a correction cannot be thus made; in such cases the coma must serve as a guide. The edge of a red blood-corpuscle will serve as a good test for practice in this way. By carefully moving the collar back and forth until the edge is sharp and clear, it will be seen that a brisk movement of the fine adjustment causes the edge of the corpuscle to expand, both as it goes beyond the focal point and also within the focal point. If the correction has been made exact, this expansion (coma) is equal both ways, but should the greater expansion be when the object is beyond the focal point, the objective is under-corrected, and the collar should be turned towards zero; but should it be the reverse, that is, the greater expansion within the focal point, the objective is over-corrected, and the collar should be moved towards closed."

The author then refers to the deceptive appearances produced by a want of proper correction, such as lines or network instead of dots and points; and that with homogeneous-immersion objectives without

correction-collar the draw-tube should be pushed in if the object appears too green, or if too pink drawn out until the ruby tint is obtained, assuming, that is, that the objective corrects in that colour.

In the above note we remark that Professor Moore does not specify whether the $\frac{1}{15}$ objective was dry or immersion. It should also be observed that in testing the colour-corrections of a large-apertured immersion objective on a dry Podura adhering to the cover-glass, it may happen that there is an appreciable film of air between the scale and the surface to which it adheres, in which case the "ruby" tint may be replaced by a deep red colour which cannot be corrected by the adjustment collar. The objective will then be acting as a badly corrected dry lens. In such a case a scale must be sought that is more closely adherent to the cover-glass.

It is a fact well known to opticians that objectives of large aperture which are very perfectly achromatized do not yield such sharp definition of a dry *Podura*-scale as those in which the outstanding colour-aberration is of a moderate ruby tint. The more closely adherent the scale is to the cover-glass, the less red should be the tint; and if by means of the vertical illuminator or equivalent means a scale is chosen which adheres closely, the ruby tint will be less pronounced, and the definition generally more perfect.

Measuring Thickness of Cover-glass by Correction Collar.*— Professor C. K. Wead points out that the thickness of a cover-glass "may be found quite closely by means of an objective with correction. Taking the covers used above [·0058 inch and ·0123 inch], and having focussed on dust or finger marks on the under side, turn the collar till dust on the upper side is in focus; with the thinner glass several trials gave as the reading of the collar 3°·6, 3°·75, &c.; working backwards focussing on the top with the collar at 9°·6 and then on the lower side by the collar the reading was 6°·1 twice, a change of 3·5; mean of seven trials gave 3°·56; similarly with the thicker cover, mean of five trials gave 7°·58. If we assume the change of the collar to be just proportional to the thickness of the glass, since the thin glass is ·0058 inch we should have 3·56 : 7·58 :: ·0058 : thickness of thick cover: solving we find it to be ·01235 inch—a difference of less than $\frac{1}{1000}$ inch from that found by a Brown and Sharpe's gauge—a quantity scarcely measurable with this gauge. If one has, then, a single cover-glass whose thickness is known, by a simple proportion the thickness of any other one can be found in a moment. For this particular lens the reading of a collar multiplied by 1·6 will give very closely the thickness in thousandths of an inch. Makers might easily furnish for their lenses the constant multiplier to be used as this 1·6 is; or divide the scale so as to indicate directly the thickness in thousandths of an inch."

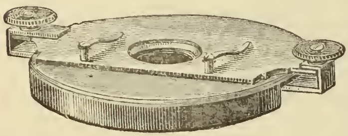
Bausch and Lomb Optical Co.'s Glass Stage and Slide-carrier.†—This (Fig. 128, see also Fig. 113) is intended as a substitute for the mechanical stage to a certain extent. It consists of a

* 'The Microscope,' ii. (1882) p. 72.

† From the Company's Price List, 7th ed., 1882, p. 5 (1 fig.).

polished plate of glass, incased in a brass ring, which clamps on the circular stage. The slide-carrier, which moves on it, consists of a light metallic plate, and has protruding from its lower surface four small points; at its two ends are prolongations, which are bent downward and inward, and, acting as springs, press against the lower surface of the glass. As the contact between glass stage and slide-carrier is only in these six points, friction is reduced to a minimum, and the action of the latter, although firm, is smooth and steady.

Fig. 128.

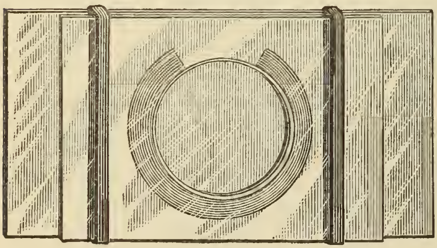


It is claimed that it enables work to be done with far more facility than in the ordinary brass stage, where the entire surface of the slide bears on it, and that it is altogether more agreeable. The slide-carrier is provided at each end with small milled heads for manipulation, and has spring clips and a stop for Maltwood finder.

Thomas' Vivarium.—Mr. C. Thomas has devised a life-slide which is in effect a modification of the Hardy vivarium, enabling it to be readily applied to observations with high powers. With the earlier form, the upper plate is necessarily so thick that it is impossible to use it for the examination of such organisms as the Cilio-flagellata which require the highest powers.

The new vivarium is shown in Fig. 129, with the two principal plates held together by two indiarubber bands, and a segment of another band forming the sides of the cell as in the Hardy vivarium. The speciality of Mr. Thomas' device is the addition of a third plate of *thin glass*, contiguous to the upper plate and of about the same size, the latter being pierced with a central aperture. We thus have a cell the upper side of which is thin enough to allow high powers to work through it. The thin glass is so supported by the upper plate, with which it is in contact over the greater part of its surface, that we have found from experience that there is practically no risk of breaking it in putting the cell together. A piece of very thin glass can be placed inside the cell and kept close up to the front by wedging it with a small piece of rolled or twisted paper.

Fig. 129.



The upper plate is made shorter than the lower so that there may be no danger of the plates being pressed together unequally and the thin plate crushed when the apparatus is taken up by one end.

Bausch and Lomb Optical Co.'s Immersion Illuminator.*—This (Fig. 130) is designed to utilize the full capacity of medium

* The Company's Price List, 7th ed., 1882, p. 32 (2 figs.).

and wide-angled objectives. In general appearance it is like an ordinary objective. It has an internal diaphragm, which is placed directly under the posterior system of lenses, and is entirely contained in the tube comprising the mounting, therefore avoiding any projection, and allowing the light to enter only from below. By revolving the milled ring of the mounting, the diaphragm is made to pass laterally from the centre to the extreme edge of the illuminator, thereby throwing rays of any desired obliquity, between 0 (central illumination) and the extreme possible limit, 1·52 in crown glass. When the diaphragm is at its extreme limit a second slit, at right angles to it, giving the same volume of light, is opened by the further movement of the milled ring, thus utilizing two pencils at right angles. The illumination is said to be amply sufficient with the highest powers, and the fact that it is used with only central illumination of the mirror, will, it is considered, "prove especially valuable to those who do not possess instruments with the modern swinging substage and mirror-bar."

Fig. 130.

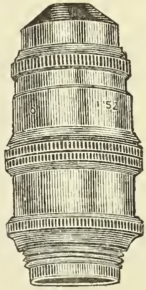
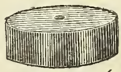


Fig. 131.



The illuminator is also said to give excellent results when used as non-immersion. A cap with minute aperture (Fig. 131) to facilitate centering, and an adapter (to receive the optical part without the diaphragms and so to give full aperture) accompany it.

Gundlach's Immersion Condenser.*—E. Gundlach discusses this subject, and expresses the opinion that of all the apparatus for providing oblique illumination for large apertures, the Abbe condenser has apparently been the most efficient, and has been generally adopted as the most suitable illuminator for the widest angled objectives, hence it is advisable to inquire whether this form of condenser is capable of doing all that is demanded of it now, or that will be demanded in the near future; and to this inquiry he has given much special study. As the full advantage of a very wide-angled objective cannot be had unless light can be made to pass through any part of its aperture at will, the Abbe condenser would be the best, if it were possible, practically, to increase its angle to correspond with that of the objective; but it can be shown, Mr. Gundlach considers, that it cannot be so increased, and that it cannot approach within 20° or more of 1·52 N.A., as is now, or soon will be, desirable.

"If the point where the optical axis of the objective cuts the plane of the object be considered the vertex of an angle which has the extended optical axis of the objective for one side, then the other side of the angle extended downward will cut the under side of the slide on which the object is mounted, at a certain distance from the axis, and this distance is proportional to the thickness of the slide. Besides, if the said angle is equal to half the angle of aperture of the objective,

* Amer. Mon. Micr. Journ., iii. (1882) pp. 85–7 (1 fig.).

then this distance is the radius of a circle which the available front of the condenser, or other apparatus, must cover, so that light may enter the objective at the most extreme angle of obliquity. If this distance, which we will call d, be $\frac{3}{16}$ inch, then the available surface of the condenser must be a circle of at least $\frac{3}{8}$ inch in diameter.

"Now, assuming the thickness of the usual object slide to be $\frac{1}{12}$ inch, though this is hardly enough, if the angle of aperture of the objective is given, we may find the distance d, for with the thickness of the slide, $\frac{1}{12}$ inch, as the cosine, the distance d will be the sine of half the angle of aperture of the objective. If the angle of the aperture of the objective be 120°, or 1·31 N.A. in crown glass of 1·52 refractive index, then the distance d would be 0·144 inch, which, however, will not introduce any special difficulty in the construction of an Abbe condenser, as the connecting, or front, surface of the condenser need not be larger in diameter than 0·288, or a little over $\frac{1}{4}$ inch. But when we come up to 140° crown-glass angle, or 1·42 N.A., the distance d increases at once to 0·228 inch, and the connecting surface of the condenser must be at least 0·456, or nearly $\frac{1}{2}$ inch in diameter. With so large a front surface, or as it is better expressed, front aperture, the condenser to be fully up to 140° crown glass, will have to be of an equivalent focus of at least $\frac{1}{2}$ inch, which with 140° in crown glass, will make the back-aperture 1·42 inch, or near $1\frac{7}{16}$ inch, and in mounting it will be pretty close work to get this inside the substage tube. But let us go a step further and suppose an objective of a crown-glass angle of 160° or 1·49 N.A., which may be expected before long. This angle will increase the distance d to 0·47 inch, and the diameter of the front aperture of the Abbe condenser must be at least 0·94 or $\frac{15}{16}$ inch. Now, as the increase of the angle of aperture of the condenser from 140° to 160° will considerably lessen its working distance, it will have to be constructed of so much longer equivalent focal distance as to keep the working distance of the slide thickness, of at least $1\frac{1}{3}$ inch focus (*sic*), and even with this it will be hard to get the required working distance. But a condenser of $1\frac{1}{3}$ inch equivalent focus and 160° crown-glass angle will require a back-aperture of 3·98 inches.

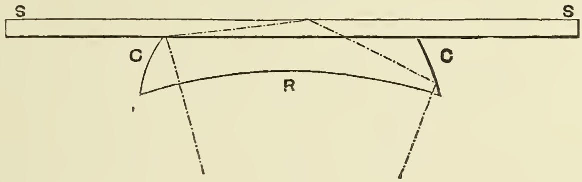
"Attaching this mammoth condenser to a Microscope having a stage, and consequently all the base parts that support it, on the same scale, we should have an instrument of such proportions as would give the appearance of a derrick, rather than that of a Microscope.

"These examples satisfy us that the Abbe condenser, useful as it is, by no means fully meets all the requirements of oblique illumination, and that practically this illumination cannot very well be made of greater angle than it already has. Hence we have either to find some other suitable means of obtaining still more oblique illumination, or to give up, as useless, the increase of the angle of the object for an increase in performance.

"So it is wise to consider the solution of this problem of illumination before the further improvement of the objective by the increase of angle. In this direction, I desire to submit for consideration the idea of an oblique light reflector represented in Fig. 132. S represents the

object-slide; R the proposed reflector. It is a section of a sphere. The upper plane surface is to be brought in contact with the slide by means of a suitable fluid in the usual way. The under surface is concave. The dotted lines show the direction of the light, which

FIG. 132.



undergoes an inner total reflection at the surface C. Perhaps this reflector will answer for the next limited period; and when even this shall prove to be insufficient, I propose to mount the object on the plane surface of this reflector. In this way the theoretical limit would be reached, and opticians can go on constructing objectives that will take and utilize the oblique light of this reflector."

[It is unnecessary to provide for any apertures in excess of 1·45; and the assumption of $\frac{1}{12}$ inch for the thickness of the object-slide is unnecessarily large, $\frac{1}{16}$ inch being the average. With these alterations the maximum figures given by Mr. Gundlach ($\frac{15}{16}$ inch for the front lens and 3·98 inch for the back lens) would be reduced.—ED.]

Symmetrical Illumination.*—Mr. Gundlach also desires "to call attention to another idea, which, if carried out properly, may be of advantage. I thought that a good result would be obtained if the object should be obliquely illuminated symmetrically, i. e. from diametrically opposite sides at the same time, with equal obliquity, intensity, and quantity, rather than from one side only; for the secondary spectrum, with the unavoidable slight chromatic over-correction of the outer part of the objective, produces a more or less visible and disturbing spectrum, which will be neutralized in the proposed way. I have tried this, and after some difficulty I think I succeeded in obtaining a result in resolving which I could not get in the usual way. From my limited experience in this matter I can say, however, that this symmetrical illumination requires a very delicate fine adjustment; the one I used gives a motion of only $\frac{1}{360}$ of an inch at a full turn of the screw; for apparently the two images, projected separately by the illumination from each side, do not move in the direction of the optical axis when the screw is turned, but they move each toward the side from which they are projected, and it requires great precision to get them to coincide perfectly. Further desirable experimenting in this, for which I do not deem myself competent, I feel obliged to leave to experienced and skilful microscopists, and I

* Amer. Mon. Micr. Journ., iii. (1882) p. 88.

shall be grateful if informed of the results of any experiments tried by them."

Gundlach's Substage Refractor.*—This apparatus, intended for measuring the aperture angle of wide-angled objectives, consists of a small crown-glass cube, with sides about $\frac{3}{16}$ inch. One face is opaque, the one opposite and the two others opposite each other, polished. The cube is made to adhere, by means of a suitable homogeneous medium, to the front surface of the objective by the polished surface opposite the opaque side. Then a ray of light must enter each of the polished side surfaces in the plane described by the optical axis of the objective and a line perpendicular to those polished surfaces, and at such angular inclination to the optical axis that it will pass through the objective close at the edge of its aperture, and emerge from it in the direction of the optical axis.

The angle described by the refracted rays inside the crown-glass cube, is equal to the crown-glass aperture angle of the objective, and is :—

$$\cos n = \cos \frac{a}{r},$$

a being half the angle described by the two rays before entering the cube, r the refractive index of the crown glass, and n the crown-glass angle of the objective.

Silvered Convex Lenses v. Concave Mirrors.†—Mr. C. V. Boys points out that convex lenses silvered at the back make excellent and easily-constructed concave mirrors. Since both surfaces conduce to bring the light to a focus flatter curves may be used than are necessary for a plain concave reflector of the same focal length; also since the two surfaces are not parallel false images are not produced, so that the advantage of glass silvered at the back remains without the usual disadvantage.

Binocular Vision in the Microscope.‡—Professor C. Cramer, in connection with a description of Prazmowski's binocular eye-piece, discusses the conditions of stereoscopic binocular vision in the Microscope. In particular he points out the error of the views of Nägeli and Schwendener that the depth of the field of view is of only secondary importance to the stereoscopic effect, a view which they attempt to support by the fact that in the ordinary stereoscope the two pictures are perfectly plane, but yet produce the impression of solidity. These pictures require, however, to be taken from different points of view, or no stereoscopic effect whatever will be produced. Microphotographs of statuary, &c., do not appear to be more solid when observed with a stereoscopic Binocular than with a single eye. The author further describes the appearances, by the left- and right-hand halves of an objective respectively, of oil-globules and air-bubbles in water by transmitted light and a small cylindrical opaque object, as establishing to what in fact the stereoscopic effect is due. He also

* Amer. Mon. Micr. Journ., iii. (1882) pp. 142-3 (1 fig.).

† Phil. Mag., 1882.

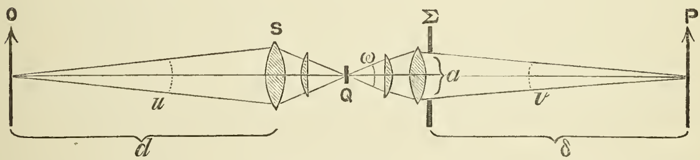
‡ Vierteljahrsschr. Naturf. Gesell. Zürich, xxiv. (1879) pp. 95-106.

discusses the effect of observing the two different images with a single eye (when each point of the object is seen in one direction only), and the difficulties attending the recognition of the respective distances of parts of an object with one eye. With *true* solid vision with two eyes they must constantly be accommodated according as we desire to see the nearer, central, or more remote parts of the object. With *apparent* stereoscopic vision this is not, however, necessary.

Finally, the author expresses his opinion as to the value of binoculars as follows:—"For the solution of natural problems the author cannot expect much of the stereoscopic Microscope since the sharpness of the image leaves much to be desired.* Its use for instruction is, moreover, rendered very difficult in that each observer must regulate not only the focus but also the lateral distance of the eye-pieces. Nevertheless, for microscopical objects of complicated form the instrument may here and there prove useful."

Miniatured Images.—In the President's Address (*ante*, p. 158) a brief reference is made to the unsatisfactory character of experiments made on miniatured images—spider-lines, for instance, "miniatured to the fourteenth part of the hundred-thousandth of an inch." The illusory character of all conclusions on the subject of microscopical vision, which are based on the observation of miniatured images, is demonstrated by the following discussion, which we extract from some notes on the subject by Professor Abbe.

FIG. 133.



Let O (Fig. 133) be an object—a grating or wire gauze, or spider-line, Q its miniature image, projected by means of an objective S, Σ the objective of the Microscope by which this miniature image is observed, and P the re-enlarged image which is finally seen through the eye-piece. The linear aperture of the objective Σ may be denoted by a; the corresponding aperture-angle by ω; the angle of convergence of the delineating pencils at the image P by v; the angle of divergence of the pencils admitted from O by u; the distance of O from S by d, and the distance of the final image from Σ by δ (these distances being measured from the posterior principal foci of the two objectives which will practically be very near to the back lenses), and f and ϕ the equivalent focal lengths of S and Σ respectively. All the conditions of the observation are now strictly defined.

* In the particular case, on account of the interposition of the prism and additional eye-piece combination.

Now what is claimed is, that if the spider-line at O is $\frac{1}{10000}$ inch in breadth, and the objective S diminishes by 100 diameters, we should have at Q a miniature image of $\frac{1}{1000000}$ inch, and that this is depicted by the objective Σ.

This is, however, pure hypothesis, without a shadow of proof that the observation of miniatured images is the same thing as that of real minute objects.* The only *fact* is, that the observer sees the object O as it is delineated by the *composite objective* S + Σ at P.

For demonstrating the fallacy involved in the assumptions in question it is not necessary to concern ourselves with any theory of microscopical vision—it is sufficient to rely on the ordinary principles of geometrical optics.†

In the first place it is readily shown that the appearance of the supposed miniature—as it is actually seen through the Microscope—has no essential connection with that miniature, the image at P, which is actually and only seen, not even requiring the existence of any miniature, so that the conditions of visibility of things are discussed which need not even exist at all.

Suppose the objective S under-corrected and Σ over-corrected in a corresponding degree—the aberrations of both systems just balancing one another—the object at O will be visible at P with the same distinctness as if S and Σ were strictly corrected; for the total system (S + Σ) is so corrected. Now it is obvious that under the above assumption (antagonistic correction-defects in the two systems) no image of very minute dimensions can be depicted at Q at all, where we should only have large circles of confusion.

It need hardly be said that it is an obvious fallacy to infer anything concerning the existence or operation of a given phenomenon from observations which would not be altered in the least degree if that phenomenon did not exist at all.

The true signification of the observations in question is obtained by determining the optical character of the composite system (S + Σ). This can be done by the following formulæ, which give respectively (*a*) the focal length, (*b*) the amplification, and (*c*) the aperture angle, by which three things the action of every optical system is perfectly determined. If two systems are identical in all these respects (and

* Whether a real (isolated) object, such as a fine line (bright or dark) of $\frac{1}{1000000}$ inch is visible or not visible through a given objective is only a question of light, of sensitiveness of the observer's retina, and of good correction of the objective, just as in telescopic vision a single star is always visible, however small its visual angle, provided it is sufficiently bright, but a double star requires a certain minimum aperture of the telescope depending on the angular distance apart of the stars.

† On the principles of the Abbe theory of microscopical vision the matter would stand thus:—If there were at O a coarse object of say $\frac{1}{10}$ inch in diameter, the miniature image would in fact be approximately the $\frac{1}{100}$ part in diameter, i. e. $\frac{1}{1000}$ inch. But this is not the case with objects and images of such minute dimensions as above referred to, the miniature of the spider-line, if it could for instance be photographed (the system S being absolutely free from aberrations) would be found to be a rather broad band not less in diameter than half the wave-length of light.

equally well corrected) they must always give the same image of the same object. With the notation indicated above, the equivalent focal length F of the total system (S + Σ) is

$$\frac{1}{F} = \frac{f}{\phi} \cdot \frac{1}{d} + \frac{\phi}{f} \cdot \frac{1}{\delta},$$

the linear amplification N (of the ultimate image at P),

$$N = \frac{\delta}{d} \cdot \left(\frac{f}{\phi}\right),$$

and the aperture angle u of the total system (resulting from the linear aperture α of the objective Σ),

$$u = \frac{\delta}{d} \cdot \frac{f}{\phi} \cdot v \text{ (where } v = \frac{\alpha}{\delta}\text{)};$$

therefore

$$u = \frac{\alpha}{d} \cdot \frac{f}{\phi}.$$

To take an example: let S be an $\frac{1}{8}$ inch and Σ a $\frac{1}{12}$ objective, d = 400 mm., δ = 200 mm., α = 3 mm., f = 3 mm., ϕ = 2 mm.—then we have

$$\frac{1}{F} = \frac{300}{200} \cdot \frac{1}{400} + \frac{200}{300} \cdot \frac{1}{200} = \frac{3}{800} + \frac{1}{300} = \frac{17}{2400}$$

$$F = \frac{2400}{17} = 141 \text{ mm. } (= 5\tfrac{1}{2} \text{ inches approximately})$$

$$N = \frac{200}{400} \cdot \frac{300}{200} = \frac{3}{4}.$$

The ultimate image at P is therefore a slightly (3:4) diminished image of O.

$$u = \frac{3}{400} \cdot \frac{300}{200} = \frac{9}{880}$$

which is an aperture angle of about $\frac{2}{3}°$.

Thus the simple *matter of fact* is that if the miniature of O is observed at P we observe the *real object* O by means of a very *low-power* objective ($5\frac{1}{2}$ inches) of *very low* aperture ($\frac{2}{3}°$) under a very low linear amplification, and nothing more is shown therefore by the observation but this, that spider-lines and similar things can be seen through very low-power objectives, which nobody will doubt.

The formulæ for F, N, and u show that the focal length of the actually effective system, the ultimate amplification, and the aperture angle do not depend on any other elements except (1) the distances d and δ of the object and the ultimate image, (2) the ratio of the focal lengths of the objectives S and Σ, and the latter in addition (3) on the linear aperture of the objective. Now F, N, and u, as has been said, comprise *all* elements of the effective system (S + Σ) which can possibly have any influence on its performance (spherical correction of

the total system being supposed), and the same values of F, N, and u will therefore indicate the same effect always. Consequently we shall obtain exactly the same results whether we apply an $\frac{1}{8}$-inch and $\frac{1}{12}$-inch, or instead of these any two *low*-power objectives with the same *ratio* of the powers (2 : 3), for instance a 2-inch and a 3-inch or (the simplest case) a single lens of $5\frac{1}{2}$ inches, always preserving the distances $d = 400$, $\delta = 200$ and the narrow diaphragm corresponding to the linear aperture of the $\frac{1}{12}$ (3 mm.).

These considerations show the illusory character of the experiments in question as all the observations would have had the same result even if objectives had been applied not of the high powers actually used but of low power or even consisting of a single lens, that is under circumstances in which either no miniature at all is formed, or none of the minute dimensions claimed. Nothing can be inferred from such experiments in regard to *high-power* vision, at any rate. They are in fact, experiments on *low-power* vision, and under artificially and unnecessarily *complicated* conditions, a complicated system, $E + \Sigma$, composed of a number of lenses being employed for obtaining no other effects than can be produced by a single lens of small aperture.

Black Annuli and Lines of Spherules and Threads.—In the same Address * is a reference to the attempts made to demonstrate the defective vision of objects under objectives with wide apertures, by means of glass spherules and threads, the characteristic black lines seen when low apertures are used nearly disappearing when the aperture is increased.

It is true that transparent spherules and threads of 0·1 inch in diameter, or many times greater than a wave-length, behave according to the laws of refraction, and show annuli, &c., which are very strong and black with low apertures, but are much less marked with wide ones, but very minute spherules or filaments of the same shape, which are only a wave-length or less in diameter, do not show the black annuli and lines *even with the narrowest apertures*. They appear either uniformly illuminated or with a gradation of light which has not the least similarity to the annuli, &c., of the coarser refracting spheres or cylinders, and this for the reason that such minute objects do not act as *refracting* bodies but only by the retardation of the transmitted waves.

This shows the essential fallacy involved in the experiments in question. That the black annuli of the coarse objects become indistinct with wide apertures proves only that wide apertures are not the proper means for examining such coarse objects. This, however, requires no proof nowadays, when it is well recognized that wide apertures should not be applied for objects which are completely depicted by low ones.

The notion that minute objects which require high powers in order to be seen are better seen with low apertures, is a conclusion derived not from direct observation, but simply *inferred* from the *supposed*

* pp. 158–9.

analogy of the phenomena presented by large objects, and with the assumption that the same phenomena must hold good in the other case also.*

Curiosities of Microscopical Literature.—One would hardly have expected to find such a paragraph as the following in a book published in London in 1881, even although written "without assuming the possession on the part of the reader of other attainments than those possessed by the average schoolboy or schoolgirl":—"In the "same year (1824) Tulley, of London, succeeded in constructing for "the first time in England an object-glass of 3 lenses. Sir John "Herschel, Professor Airy, and Professor Barlow [no mention of "Lister!] furnished valuable contributions to the theory of the "achromatic object-glass. More recently a suggestion of Sir David "Brewster's has been carried out, by the construction of lenses of "diamond. By these and other modern improvements, especially in "the mode of illuminating the objects, investigations are now carried "into structures so minute that magnifying powers of 2000 or 3000 "diameters have to be used"! †

The suggestion of diamond lenses was *abandoned* more than fifty years ago,‡ and none of the present generation of Microscopists have ever had an opportunity of testing the "improvement" which it is suggested the diamond has been to microscopical investigation.

When will popular writers get to understand that neither the size nor the magnifying power of a Microscope forms the standard of its efficiency, and that amplifications of 2000 or 3000 diameters could be obtained without any difficulty half a century ago, when, notwithstanding, much less was visible than can now be seen with a tenth of the power.

In a subsequent paragraph it is stated that the "binocular form of construction, though attempted very long ago, was not successfully carried out till 1851."

* It must also be borne in mind that it is impossible to make reliable observations as to the relative performance of objectives with different apertures, unless the fact of their perfect correction is ascertained *independently of the observations in question*, that is on objects the correct appearance of which is not dubious or hypothetical, as for instance, the outlines of thin silver films.

Again, it is out of the question in *such* observations to make arbitrary changes in the conditions under which the objective acts, as shortening and lengthening the tube, interposing other lenses between the objective and the eye-piece, using the objective with immersion fluids for which it was not constructed, &c.

As wide apertures allow of much greater aberration than low ones, it may happen that the former, if the correction is not very carefully made, will show less than a low aperture, even if this is also badly corrected, because the relative deterioration of the image is not so great.

† 'A Popular History of Science,' by R. Routledge (8vo, London, 1881) p. 515.

‡ Dr. Goring suggested diamond lenses to A. Pritchard in 1824, and he made one in the same year (see Sir D. Brewster's 'Treatise on the Microscope,' 1837, pp. 13–21). Sir D. Brewster's reference to diamond lenses will be found in 'Treatise on New Philosophical Instruments,' 1813, pp. 402–10; and 'Treatise on Optical Instruments,' 1832, p. 39.

Abbe's Fluid for Homogeneous-Immersion Objectives. [*Ante*, p. 551.]
Bull. Soc. Belg. Micr., VII. (1882) pp. clvi.–vii.

"Akakia."—Abbe's Apertometer.
[Describes his mode of use. Also replies to question of "Antares" as to whether homogeneous-immersion objectives are useful only where apertures greater than 1·33 are required. *Supra*, p. 685.]
Engl. Mech., XXXV. (1882) p. 551.

American Society of Microscopists.
[Note as to the prospects of the Elmira Meeting.]
Amer. Mon. Micr. Journ., III. (1882) pp. 135–6.

Bizzozero, G.—Manuale di Microscopia clinica. (Manual of Clinical Microscopy.) 2nd ed.
8vo, Milano, 1882, xii. and 246 pp. (44 figs. and 7 pls.).

Blackham, G. E.—Presidential Report and Address (The Evolution of the Modern Microscope) to the Elmira Meeting of the American Society of Microscopists.
[Brief abstracts with omissions. The Report contains recommendations to re-appoint the Committee on eye-pieces, and that (*à propos* of the Griffith and Stowell prizes) the whole subject of giving prizes be taken up, and the fixed policy of the Society in regard thereto be decided upon and announced. "It will require careful consideration, as there is much to be said both for and against the practice." The Address traces the history of the Microscope from the end of the sixteenth century to the present time.]
Amer. Mon. Micr. Journ., III. (1882) pp. 170–3.

Bradbury, W.—The Achromatic Object-glass, VII.–X.
Engl. Mech., XXXV. (1882) pp. 489–90, 537–8;
XXXVI. (1882) pp. 26–8, 78–80.

Brébisson, A. de.—See Chevalier, A.

Brewer, W. H.—Apparent Size of Magnified Objects.
[Abstract of paper presented in the Sections of Histology and Microscopy at the Montreal Meeting of the American Association for the Advancement of Science. *Post.*]
Amer. Mon. Micr. Journ., III. (1882) p. 161.

Brittain, T.—The Beginnings of Microscopic Study.
[Several corrections necessary. (1) Baker (and not Trembley) is credited with the first demonstration of the vitality of *Hydra* when cut to pieces, while (2) the discovery of achromatism and the manufacture of achromatic lenses and the revolution which they caused in Microscopy has been lost sight of, the position of the Microscope in 1830 being thus dealt with:—"About 1830 the mechanism and general arrangements of the materials employed began to show a great advance upon the older instruments, but it was in the lenses that the chief improvements were manifest, and principally in the higher powers. The lower powers, composed of a single lens, remained much as before, while the improvements in the higher powers were carried on to a wonderful state of perfection. The provoking refraction which interfered with the definition of an object when seen with a high power is now got rid of, and what was obscure and doubtful before is no longer so, but becomes a matter of demonstration."]
Field Naturalist, I. (1882) pp. 80–1.

Carpenter, W. B.—Address on the Practical and Theoretical Results in the History of the Microscope.
[Abstract of Address to the Section of Microscopy at the Montreal Meeting of the A.A.A.S. Relates mainly to the relative value of objectives of small and large aperture.]
Amer. Mon. Micr. Journ., III. (1882) pp. 161–3.

Chevalier. A.—L'Étudiant micrographe, traité théorique et pratique du Microscope et des préparations. 3e édition, augmentée des applications à l'étude de l'anatomie, de la botanique et de l'histologie, par MM. Alph. de Brébisson, H. Van

Heurck, G. Pouchet. (The Micrographical Student, theoretical and practical treatise on the Microscope and preparations. 3rd ed., with additions on its applications to the study of anatomy, botany, and histology.) xvi. and 591 pp. Portrait, 179 figs., and 7 pls. 8vo, Paris, 1882.

CRISP, F.—Notes sur l'Ouverture, la vision microscopique et la valeur des objectifs à immersion à grand angle. (Notes on Aperture, Microscopical Vision, and the value of wide-angled Immersion Objectives)—*contd.*

[Transl. of paper, *ante*, I. (1881) pp. 303–60.]

Journ. de Microgr., VI. (1882) pp. 362–5 (3 figs.), 417–8 (3 figs.).

DAVIS, G. E.—Prof. Abbe's Paper on the Relation of Aperture and Power in the Microscope. *North. Microscopist*, II. (1882) pp. 211–2.

„ „ A Plea for Wide Apertures.

[" A reply to Prof. Abbe's paper 'On the Relation of Aperture and Power in the Microscope.' "]

North. Microscopist, II. (1882) pp. 229–38 (1 pl. of 4 photos.).

„ „ How to Found a Local Microscopical Society.

North. Microscopist, II. (1882) pp. 212–6.

DIPPEL, L.—Das Mikroskop und seine Anwendung, 1er Theil. Handbuch der Allgemeinen Mikroskopie, 1e Abtheilung.

2nd ed., 8vo, Braunschweig, 1882, viii. and 336 pp., 189 figs.

„ „ Die Correctionsfassung bei Objectiv-Systemen für homogene Immersion. *Zeitschr. f. Instrumentenk.*, II. (1882) pp. 269–74.

DYCK, F. C. VAN.—Significant Angle.

[Objections to the paper of the Hon. J. D. Cox, *ante*, p. 422.]

Amer. Mon. Micr. Journ., III. (1882) pp. 154–5.

ENGELMANN, T. W.—Ueber Sauerstoffausscheidung von Pflanzenzellen im Mikrospectrum. (On the disengagement of oxygen by vegetable cells in the Microspectrum.)

[Contains a description of the Microspectroscopic Apparatus, *ante* p. 564, and *supra* p. 661.]

Bot. Ztg., XL. (1882) pp. 419–26 (1 fig.).

FLESCH, M.—Beleuchtungsvorrichtung zum Mikroskopiren bei künstlichen Licht. (Illuminating Apparatus for Microscopical Observations by Artificial Light.)

[The numerous lamps of often complicated structure are superfluous for histologists or for other purposes than resolving test objects. Light modifiers of tinted glass are, however, useful, and can be arranged to be conveniently placed in the carrier-plate of the Abbe condenser.

Sep. repr. *SB. Phys.-Med. Gesell. Würzburg*, 1882, 2 pp.

GRUNOW'S (J.) New Microscope.

[No speciality in form.]

Amer. Mon. Micr. Journ., III. (1882) pp. 146–7 (1 fig.).

GUNDLACH'S (E.) Substage Refractor.

[For measuring the apertures of wide-angled objectives. *Supra*, p. 692.]

Amer. Mon. Micr. Journ., III. (1882) pp. 142–3 (1 fig.).

GUNDLACH, E.—A Simple Method of determining the Angle of Aperture of Immersion Objectives.

[Apparently the same as the preceding.]

Amer. Mon. Micr. Journ., III. (1882) p. 176.

GUNDLACH'S $\frac{1}{100}$-in. objective.

[Notices its intended manufacture. " We hope to live long enough to see it."]

Amer. Mon. Micr. Journ., III. (1882) p. 158.

HEURCK, H. VAN.—See Chevalier, A.

HITCHCOCK, R.—Physicians and Microscopists.

[Rejoinder to the 'Medical Register' as to their comments on the original note, *ante*, p. 423.]

Amer. Mon. Micr. Journ., III. (1882) p. 136.

Hitchcock, R.—Uniformity in Oculars.
["The only way to secure uniformity is to convince purchasers of its importance."]
Amer. Mon. Micr. Journ., III. (1882) pp. 155–6.
" " Table of Numerical Apertures.
[Brief additional remarks.]
Amer. Mon. Micr. Journ., III. (1882) p. 156.

M., W. H.—Schrauer's Microscope.
[Travelling instrument with removable base, not requiring a box, but to be "laid between other goods in one trunk."]
Amer. Mon. Micr. Journ., III. (1882) pp. 158–9.

Mackenzie, J.—Two forms of gas lamp specially for use with the Microscope. (Exhibited.)
[No description.]
Journ. Quek. Micr. Club, I. (1882) p. 105.

Martens, A.—Ueber die hygienische Ausstellung in Berlin. (On the Hygienic Exhibition in Berlin.)
[Records the fact of the exhibition of various Microscopes, apparatus, and preparations.]
Central-Ztg. f. Optik u. Mech., III. (1882) pp. 145–6.

'Northern Microscopist' Verification Department (*contd.*).
North. Microscopist, II. (1882) pp. 239–40.

Numerical Aperture and Micrometric Tables.
[From pp. 7 and 8 of the Wrapper of this Journal.]
Amer. Mon. Micr. Journ., III. (1882) p. 134.

Pelletan, J.—Microscope "Continental" ("Continental" Microscope).
[p. 356: Announcement that it will be ready for delivery on 1st September.—"It represents a 'Centennial' of Zentmayer or a 'Congress' of Bulloch constructed à l'Européenne." pp. 406–7: Description of the instrument.]
Journ. de Microgr., VI. (1882) pp. 356, 406–7 (1 phot.).

Pinkernelle, W.—Apparat zur Erleichterung der Mikroskopischen Untersuchung von Flüssigkeiten. (Apparatus for facilitating the microscopical observation of fluids.)
[Abstract of German Patent, No. 18,071, 31st May, 1881. Simply a slide made of two glass plates cemented together with a channel between them. A tube connected with one end dips into an open vessel with the fluid to be examined, and one connected with the other passes through the cork of a closed receiver, which is also pierced by a second tube ending in an indiarubber ball. A stop-cock at each end of the slide regulates the flow.—Also suggestions for simplifying it by substituting a long tube for the receiver so as to act as a siphon.]
Central-Ztg. f. Optik u. Mech., III. (1882) p. 155 (1 fig.).

Pouchet, G.—See Chevalier, A.

President's Address [Abstract of, *concld.*].
Amer. Mon. Micr. Journ., III. (1882) pp. 128–32.

"Prismatique."—Object-glass working, I.
[Practical directions.]
Engl. Mech., XXXVI. (1882) p. 54.

Royston-Pigott, G. W.—Microscopes and Microscopy.
[Lecture to the 'Eastbourne Young Men's Christian Association.']
Engl. Mech., XXXV. (1882) pp. 231–2.

Standard Gauges for Eye-pieces and Substages.
[Note on the Committee's report, *ante*, p. 595—"it is to be hoped that for the future eye-pieces will only be made of the specified sizes; the inconvenience attending the parts of various instruments not being interchangeable is very great, and might in the course of a few years disappear if all new instruments were made to the standard sizes."]
Journ. of Sci., IV. (1882) pp. 502–3.

Steinheil's Achromatic Eye-pieces.
This Journal, II. (1882) p. 551 (2 figs.).
Engl. Mech., XXXV. (1882) p. 570 (2 figs.).

Stroebelt, O.—Eine verbesserte Vorrichtung mikroskopische Beobachtungen unter dem Einfluss elektrischer Schläge anzustellen. (An improved arrangement for microscopical observations under the influence of el ctrical shocks.) [*Post.*]
Zeitsch. f. Instrumentenk., II. (1882) pp. 274–5 (1 fig.).

Treskow, H.—Führung am Objectivtische des Mikroskops nebst Compressorium. (Carrier to the Stage of the Microscope with Compressorium.)
German Patent, No. 13,399, 9th September, 1880, 2 figs. (1 pl.).

Vorce, C. M.—[Note as to easy and quick resolution of *Amphipleura pellucida* in balsam by Bausch and Lomb $\frac{1}{6}$-inch and $\frac{1}{8}$-inch objectives, with mirror central, sunlight, and no condenser.]
Amer. Mon. Micr. Journ., III. (1882) p. 137.

Ward, R. H.—The August Meetings.
[Elmira Meeting of the American Society of Microscopists, and Montreal Meeting of the Amer. Assoc. Adv. Sci.—at the latter the new section of histology and microscopy will meet for the first time.]
Amer. Natural., XVI. (1882) p. 691.

" " Eye Protectors.
[Description and figure of Pennock's, I. (1881) p. 518, and description of Hall's, *supra*, p. 678.]
Amer. Natural., XVI. (1882) pp. 691–2 (1 fig.).

Wright, L.—Light, a course of experimental Optics chiefly with the Lantern.
[Contains an Appendix to Chap. IX. on "Diffraction in the Microscope," pp. 200–7, 17 figs.]
8vo, London, 1882, xxiv. and 367 pp. (190 figs. and 8 pls.).

β. Collecting, Mounting and Examining Objects, &c.

Preservative Fluids for Animal and Vegetable Tissues, and Methods of Preservation.*—Many years ago, Professor F. Pacini commenced to make microscopical preparations with a view of preserving types of different elements of tissues, both normal and pathological, and experimented largely with aqueous solutions of different substances in variable proportions; then, having put up a large number of preparations in these solutions, he allowed some years to elapse in order to see which had best resisted the effects of time. Many, of course, perished; but those which are preserved serve to indicate the best methods to employ.

Professor Pacini does not deal with the well-known methods of preserving, by means of Canada balsam or glycerine, microscopical preparations of hard, dry, or indurated parts, merely observing that tissues, when they have been dried or indurated to obtain sections, have lost their water of organisation, and are not suited to give an exact idea of their minute structure; it is necessary that they should be preserved in an aqueous medium of low density, in order that they may present as natural an aspect as possible. Very thin sections of tissues, when preserved in so dense a medium as Canada balsam or glycerine, become transparent; it is then necessary to stain them in order to render them visible, and whilst they are then certainly more pretty to look at, they are not natural.

* Journ. de Microgr., iv. (1880) pp. 136, 191, and 235.

The fluids themselves, whose use the author describes, are already known; the new matter in his present communication is the account of the modes in which he finds they can be most advantageously used.

Bichloride of mercury, or corrosive sublimate, is the principal basis of the solutions. Combining with the histological elements, both animal and vegetable, it renders them insoluble, so that they can be preserved indefinitely in an aqueous medium. But, as the bichloride of mercury coagulates and precipitates the albuminous matter that exists in the interstitial fluids of the tissues, to prevent this coagulation salt is associated with it for certain preparations, and acetic acid for others, and in more or less considerable quantities, according to the effects to be obtained.

		Parts.
I.	Bichloride of mercury	1
	Distilled water	200
II.	Bichloride of mercury	1
	Common salt	2
	Distilled water	200
III.	Bichloride of mercury	1
	Common salt	4
	Distilled water	200
IV.	Bichloride of mercury	1
	Acetic acid	2
	Distilled water	300

No. I. is of limited use, but will preserve indefinitely all histological substances, both animal and vegetable, which are solid and non-albuminous, for hollow substances either swell or become too opaque by the coagulation of the albumen. It can, however, generally be substituted for the other solutions when it is desirable to entirely remove the salt or acetic acid from the solution in which any given preparation has been placed.

No. II. may be generally employed for all tissues both cellular and fibrous, animal or vegetable, provided they are sufficiently dissociated in sections of extreme thinness, because they become somewhat opaque, regaining, however, in time a certain transparency. It is especially useful for the blood-corpuscles of cold-blooded animals having a less density than III.

No. III. serves specially for the blood-corpuscles of warm-blooded animals.

No. IV. serves best for the nuclei of animal tissues, but it swells up the fibres and distorts the forms of the cells. Still, in certain cases it is very useful, and it preserves the white blood-corpuscles admirably.

All the solutions should be employed in sufficiently large quantities, and the specimen kept in it for 4–5 days or longer, in order that it may have time to take up a sufficient quantity of the bichloride of mercury before being finally closed up.

The use of metallic instruments is to be avoided, because, being attacked by the bichloride of mercury, they give rise to cloudy precipitates, which render the prepared objects thick. Sections should be cut before plunging them in the solution, and when it is necessary to tease out the elements of a tissue it should be done with porcupine quills or pointed goose-quills.

If it is wished to preserve red blood-corpuscles, the blood must be diluted with at least 50 to 100 times its volume of solution II. (or No. III., see above); this is decanted after the lapse of 24 hours, and changed in the same way three or four times. White blood-corpuscles may be isolated by destroying the red ones; this end is attained by the use of solution IV., by means of the acetic acid contained in it. It must be applied for 48 hours in the proportion of from 50 to 100 times the volume of the blood, and must, as in the former case, be changed three or four times. If transferred to solution II., the leucocytes gradually regain their original form. Spermatic fluid is preserved in solution II. The liquid must first be stirred round with a glass rod to prevent the elements adhering.

Epithelia are examined in the same solution after the parts which support them have remained some days in the solution, spread out, if necessary, on sheets of guttapercha with cactus thorns.

Blood-vessels may be beautifully injected naturally by putting the tissues which contain them into solution II. or III. for a considerable time (fœtus eyes intended to show the vessels of the pupillar membrane should be treated thus for 20 days). Nerve-fibres may be studied advantageously in the cranial and intra-ocular nerves with their comparatively thin medullary sheaths. Muscular fibres are best examined in the muscles of *Petromyzon* after a treatment of several days with solution II.

If it is desired to collect Infusoria or other very small organisms, animal or vegetable, particularly when they are in movement and scattered through a large quantity of water, a tolerably large glass vessel (in order to collect a sufficient quantity) should be filled with the water, and a little of the solution No. II. added. All the Infusoria being killed by the bichloride of mercury, they fall slowly (in three or four days) to the bottom of the vessel, the more slowly as they are smaller. The greater part of the liquid is then to be decanted by a siphon and replaced by some of the solution, which should be changed three or four times. The Infusoria can then be preserved in a bottle or mounted.

Preparing Sections of Axis-cylinder. — For extensive lengths of axis-cylinder G. Bufelius * proceeds as follows:—Fragments of nerves of the dog or rabbit are laid for 24 hours in Müller's fluid. They are then transferred to an aqueous solution of corrosive sublimate (·5 per cent.) in which they remain several days, the liquid being constantly changed, until the solution undergoes no further alteration. The tissue is then teased and treated with dilute picro-

* 'Lo Sperimentale,' 1880, Nov. Cf. Jahresber. Virchow and Hirsch for 1880, p. 22.

carmine. Finally 33 per cent. alcohol, and then absolute alcohol, are applied, and the specimens mounted in dammar.

Mounting Gizzards of Insects.*—Dr. T. J. Sturt was formerly content to pull off the head of a cricket, drag with it the stomach, and attached to it the gizzard or organ containing the pyloric teeth, skin off the muscular coat with the thumbnail, cut off any portion of intestine, and then mount.

This plan, however, missed many interesting points in the stomach and gullet, and he now prefers to kill with a drop of benzine, cut off the extreme tail, pull off the head, cut off the whole intestine, and put it in a 1 oz. phial with 5 or 10 drops of liquid potash. After it has stood about half-an-hour, partly fill with water and shake it well to detach the muscular coat and tracheæ; then slit it up, wash and adjust on a slide. Drain away any moisture, apply a drop of carbolic acid, and place on the thin glass. After a few minutes this will absorb all moisture, and render it quite transparent. If it does not, put a drop of acid at the edge and tilt the slide to drive off the first acid; then put a little balsam on the edge, tilt the slide, warming it to render the balsam more limpid, and it will gradually take the place of the acid, the lines of demarcation between the two being distinctly visible.

Preparing Tape-worms.†—Dr. G. Riehm recommends the following treatment of specimens.

To prevent contraction at death, he cleans the living cestode with a brush, and holds it in the hand until it has extended itself under the action of the warmth, and then rolls it upon a glass tube and plunges the whole into spirit; undue adhesion to the glass is remedied by soaking in water. Such specimens are well adapted for mounting under pressure; they may be stained with alum-carmine or with hæmatoxylin; if with the latter, the specimen should be treated with acetic acid for a minute after staining and then washed in ammonia to remove excess of colour.

For minute investigation, sections made parallel to the flat surfaces are preferable. To prevent the last sections breaking out of the imbedding mass, this should be made of equal parts of paraffin and white wax with the addition of one or two drops of Canada balsam dissolved in turpentine for each gramme of the mixture. The razor should be wetted with benzine, care being taken not to moisten the object itself too much with the benzine. To secure having the sections cut in the right place, the specimen is soaked in turpentine, placed in a watch-glass of imbedding mass kept liquid by heat, and left there until seen by its transparency to be thoroughly penetrated; some of the mass is then removed with a hot instrument and placed on a slide and pressed out, the specimen is placed on the stage of the microtome and the slide with its paraffin is placed on it; when cool the slide may be removed, leaving the specimen imbedded in a strictly horizontal position. The excretory vessels are injected with

* Engl. Mech., xxxv. (1882) p. 282.
† Zeitschr. Ges. Naturwiss., vi. (1881) pp. 547–51.

Berlin blue by simple insertion of the syringe; if the animal is moving actively the injection runs forward with difficulty and in any case the neck and head require manipulating with the finger or a wet brush, in order to drive the injection through the narrow portions of the vessels which occur at the joints.

Staining and Preserving Tube-casts.*—To stain and preserve tube-casts, A. T. Parker finds a logwood solution better than any other, made by adding five grammes of the extract of logwood, and the same quantity of alum, to 100 ccm. of water. The extract and alum should be thoroughly triturated before the water is added, and the whole then left until the extract is completely taken up by the water, which requires several hours, and then filtered. The best course to pursue in staining is to shake the bottle containing the urine, then pour it into a conical flask; after several hours, when the deposit is complete, either draw or pour off the supernatant fluid, and add to the deposit about an equal quantity of the staining fluid. At the end of one or two days, the casts will be stained a beautiful reddish-purple.

Casts prepared in this manner over nine months since, though left in the tube in which they were stained, are as perfect as at the time they were prepared. After staining, the casts can be mounted in balsam or dammar without undergoing any change.

Method for Dry Preparations.†—Dr. G. Riehm, after stating that the method of making the dry preparations recently shown has not been published by its original inventor, describes what he terms a simple and inexpensive process for attaining the same end.

After being arranged so as to show the required anatomical points, the specimen is hardened, preferably by chromic acid (Mollusca), Müller's fluid, picrosulphuric acid or (when the tendency to shrinking is not great) in alcohol. All water must then be extracted with absolute alcohol; if this is not thoroughly done, shrinkage occurs later. It is then placed in oil of lavender or oil of turpentine (the latter is, however, sensitive to traces of water), and, when quite saturated, extended with pins or otherwise on filter paper and left there for forty-eight hours. The specimen has then a brilliant white colour and maintains its colour and condition if protected from dust. The principle of the method consists in the prevention of decomposition by removal of the water and the protection of every particle from the action of the aqueous vapour and oxygen of the air by an investing film of resinous matter, the result of oxidation of the turpentine or oil of lavender. The cost of preparing such an object as the frog's intestine is about 30 pfennings ($3\frac{1}{2}$ pence, English value), and may be reduced by distilling the oil and using it again, and by employing the old absolute alcohol for approximate dehydration of other specimens, an important recommendation in the case of museums and other institutions. A dealer in Halle, named Schlüter, undertakes to supply specimens of the more

* Amer. Mon. Micr. Journ., iii. (1882) pp. 153–4.
† Zool. Anzeig., ix. (1881) pp. 672–3.

ordinary objects, prepared in this way. By comparing this process with that described at p. 706 of vol. i. (1881) of this Journal, it be seen that Dr. Riehm's is essentially the same as that of Prof. C. Semper. This gentleman asserts * his claim to the credit of having first made it public, and mentions three other scientific men who have published similar accounts. He disputes Dr. Riehm's explanation of the action of the turpentine, stating that the preparations are readily softened by water. The expense, also, in time and material is not small. Although the white colour seems to be an advantage, it may sometimes be necessary to restore as nearly as possible the colours of life, and this may be done by immersion in a mixture of glycerine and solution of sugar, and then drying; or the white objects may be painted either with honey or oil colours.

Preserving Infusoria. †—E. Maupas, referring to M. Certes' view that the exposure of the Infusoria to the action of the vapour of osmic acid should last from 10 to 30 minutes, says that this time appears to him much too long. He obtains a result much more rapid in the following way. Deposit the drop of water containing the Infusoria so that it shall spread as little as possible on the slide, and then invert it over the neck of the bottle containing the osmic acid (1 per cent.) having an opening sufficiently large so that the drop shall not touch the sides. By this plan the Infusoria never resist more than half a minute.

Mounting Mosses and Hepaticæ. ‡ — M. Delogne recommends glycerine-gelatine which is specially valuable for the study of the stipules of the Hepaticæ, organs which are ordinarily very difficult to see. A special advantage is that it renders a cell unnecessary.

Preparing Bacteria of Tuberculosis.§—Dr. E. Van Ermengem, referring to Ehrlich's improvement of Koch's method,‖ describes some modifications of his own which makes it absolutely sure in its results.

Instead of making a solution of the aniline in water, which only takes up 1 part in 30, an alcoholic solution is made, 4 grammes of liquid aniline in 20 grammes of alcohol at 40°, adding an equal quantity of distilled water, and filtering before use. The most stable coloring agents the author finds to be sulphate of rosaniline and methyl-violet B B B B B. The preparations, after having been decolorized by dilute nitric acid, are well washed in distilled water.

Baumgarten also recommends ¶ the following as more simple and expeditious than any others. After having spread the tuberculous matter on the cover-glass, it is placed in a watch-glass and covered with distilled water, to which is added some drops of a 33 per cent.

* Zool. Anzeig., v. (1882) pp. 144–6.

† Arch. de Zool. Expér. et Gén., ix. (1881) p. 360. See this Journal, ii. (1879) p. 331.

‡ Bull. Soc. Belg. Micr., vii. (1882) p. cl.

§ Ibid., vii. (1882) pp. cli.–iii.

‖ See this Journal, *ante*, p. 572.

¶ Centralbl. f. d. Med. Wiss., 24th June, 1882.

solution of caustic potash. Without any further preparation the bacteria may then be recognized under a power of 400–500, particularly if a light pressure is applied to the cover-glass so as to disengage the bacteria more completely from the detritus which surrounds them. To distinguish them more clearly from the other bacteria, the cover-glass may be dried by passing it rapidly two or three times through a flame and then staining by a concentrated aqueous solution of aniline violet or other colour. The bacteria of tuberculosis are *absolutely colourless*, while the other bacteria, micrococci, &c., are plainly coloured. The whole process only takes ten minutes.

Preparing Diatoms.*—Dr. R. S. Warren gives detailed directions for the preparation of diatoms, especially for separating them from sand and broken species, the directions for which hitherto published he thinks are insufficient. Coarse sand may be got rid of by repeated settlings and decantations, but it is different with the fine sand. Graduated settlings and decantations have been advised, but these are insufficient, as despite all care, more or less of light silt will float with the light forms of diatoms, and the heavy forms will fall to the bottom with the heavy sand. Whirling in an evaporating dish has been advised, but this is insufficient, and Dr. Warren has found no method better than the one he has used for several years, and which he has never seen described or hinted at except in regard to whirling.†

"If the material contains the lighter forms only, I first use whirling force as follows:—I take an evaporating dish of a size according to the quantity of material, and fasten it on the wheel of my turntable by means of a narrow rubber band passed over it and under the wheel. The material is diffused in five or six times its bulk of water. An empty wide-mouth bottle is near the turntable, and should have the capacity of two or three times the quantity of diffused material. Shaking the material well, I fill the evaporating dish about two-thirds, and then whirl it with considerable rapidity till I think the sand has mostly settled at the bottom of the dish, for the whirling motion causes it to fall. I then pour off the unsettled portion into the empty bottle, and add more of the material to the sand and diatoms remaining in the dish, and stir with a narrow strip of glass; the whirling is repeated; and so on with all the material. When this has been done, water is added to the portion in the dish, and the process continued till no diatoms remain in the sand. To ascertain this, the dipping-tube again comes into use. The material is treated in this way several times, till no sand can be obtained by it. If the material contains heavy diatoms like the large *Pinnulariæ*, *Triceratium favus*, and heavy disk-forms, the whirling process cannot well be used, for these heavy forms fall to the bottom of the dish with the sand.

"After the above process is ended, I proceed as follows, and this is,

* Amer. Mon. Micr. Journ., iii. (1882) pp. 111–5.

† Mr. F. Kitton subsequently (op. cit. p. 153) refers to his own papers in 'Science-Gossip,' 1877, pp. 145 and 217, as containing all or nearly all Dr. Warren's methods.

in most cases, the only method used after the boiling and washings. I have a slide of polished glass $3\frac{1}{2}$ inches by $4\frac{1}{2}$ inches; a smooth block of wood 4 inches by 5 or 6 inches, and 3 inches thick; two wide-mouth bottles of 4 to 6 ounces capacity, with thin, projecting lips, one empty, the other filled with the material thinly diffused in water; several pieces of considerable size of old worn cotton-cloth, and, for I like it best, a clean linen pocket-handkerchief, and a small table. The table I place beside my wash-bowl, which is supplied with water—not filtered in this instance—through a pipe and faucet, and on it are arranged my bottles, block, and cloths. I place the glass slide on the block, taking care that the latter is level, and, well shaking the material, pour a little of it on the slide, and then quickly pour it off, tipping the slide so that the material will flow off from a corner of it into the empty bottle. The diatoms float off into the bottle, and the sand adheres to the slide. The slide is then washed by letting water upon it from the faucet, then wiped as well as may be with one of the large pieces of cloth, and then the surface to be used is wiped with the linen handkerchief. This last wiping dries the surface thoroughly, and removes any little shreds of cotton which may have adhered to it from the cloth. Care is taken that none adhere. In this way the material is all worked over, and this treatment has to be repeated perhaps many times before the material is sufficiently rid of the sand. It may be that before this is accomplished, the sand and diatoms will cling together on the slide, causing considerable loss of the latter. This is owing to little particles of matter getting into the material from the cloths, or from the air, and cannot be prevented. As soon as this clinging is detected, which is easily done by occasionally examining the slide under the Microscope, first drying it after pouring off the material, the latter should be boiled for a minute in sulphuric acid, to which is added a little chlorate of potash while boiling. Of course the diffused material is poured into a beaker, allowed to settle, and the water drained off. It is then washed and the treatment continued. When the material is at last freed of sand, it is boiled a last time in sulphuric acid, chlorate of potash being used as before. It is then thoroughly washed and properly diffused in dilute alcohol for mounting. The alcohol should be filtered as well as the water.

"In this last process some of the diatoms will adhere to the slide, but this is of little consequence if there be plenty of material. As the cloths get pretty wet, as they will, they should be exchanged for dry ones."

Modification of Paraffin-imbedding.*—The ordinary method of imbedding delicate objects in paraffin is attended with so many objections, such as the disagreeable shrinking, brittleness, and fragility which the object shows by lying long in oil of turpentine or in a warm solution of paraffin in oil of turpentine, that O. Bütschli endeavoured for some time to find a substitute for the latter. After several experiments he found chloroform to be a very excellent sub-

* Biol. Centralbl., i. (1881) pp. 591–2.

stitute, and has used it for some time with most satisfactory results. The following is the method employed in the preparation of very delicate objects.

After having removed the water from the object in the usual manner by alcohol, it must be laid for a short time in pure chloroform, until it is completely saturated. The object is then placed in a solution of paraffin in chloroform which is so made that it is fluid at a temperature of 30–49° C., but firm at a moderate temperature. To retain it in a fluid state while the object is in it, it is sufficient to place it in lukewarm water. The author prefers a solution of paraffin in chloroform saturated at 35° C. In this the object is placed until it is thoroughly impregnated with the solution, for which $\frac{1}{2}$–1 hour is sufficient. The object is now placed in a watch-glass with a little of the solution, and the chloroform is completely evaporated at a very moderate temperature (40–50° C.), which is sometimes a long process as the chloroform escapes very slowly when mixed with paraffin. Larger objects can be transferred direct from the solution into melted paraffin in the same way as in using the mixture of paraffin and oil of turpentine. For delicate objects which must be completely and uniformly saturated with paraffin, the first method is in any case more to be recommended. Complete evaporation of the chloroform is also a necessity, for the presence of even a small quantity is apt to make the paraffin very soft. To make the sections the object can either be poured with the melted paraffin upon a small piece of paraffin, or after it has been placed in a larger mass of melted paraffin, it can be poured into a paper box in the usual manner.

This mode of imbedding is the most harmless and effective which the author has hitherto employed. Both object and paraffin form a thoroughly compact mass, which can be cut exceedingly uniformly. The paraffin which remains after the evaporation of the chloroform is of a very uniform structure without any tendency to crystallization, which very much favours the making of thin sections. With careful manipulation a thorough filling of the smallest interstices of the object can be effected, and there need be no apprehension of shrinking or brittleness.

The author (who acknowledges the assistance of Dr. F. Blochmann) mentions some of the cases for which they have found the process very successful, viz. *Amphioxus*, *Cerianthus*, tape-worms, ambulacra of Echini, decalcified ambulacra of Holothurians, gelatinous parts of Ctenophora, Hydroid polyps, &c. Of large objects, such as cross-sections of *Amphioxus* and *Cerianthus*, sections can be made without difficulty of $\frac{1}{100}$ mm. in thickness. Of small objects, as the tentacles of *Cerianthus*, or entire Hydroid polypi, sections can be made of $\frac{1}{250}$ mm.; if Thoma's microtome is used, indeed under some circumstances even to $\frac{1}{500}$ mm. if the knife be placed rather obliquely to the object.

Perenyi's Hardening Fluid.*—Dr. J. Perenyi describes a new hardening fluid for embryological purposes which has given surprising

* Zool. Anzeig., v. (1882) pp. 459–60.

results. Its advantage consists in the fact that the ova do not become porous, and that the segmentation spheres, as well as the nuclei, remain fixed in their respective divisions. The ova may be cut like cartilage.

The composition of the fluid is:—

Nitric acid (10 per cent.)	4 parts.
Alcohol	3 „
Chromic acid (0·5 per cent.)	3 „

which after a short time forms a violet fluid.

In this the ova are placed for 4–5 hours, then for 24 hours in 70 per cent. alcohol, for a few days in strong alcohol, and for 4–5 days more in absolute alcohol.

For staining, either (1) the fluid itself, or (2) the oil of cloves, can be coloured.

The first method is more convenient because quicker, since the ova are hardened and coloured at the same time. The outer albuminous coat should, however, be removed, so that the staining fluid may penetrate better. Some colouring agents, such as eosin, purpurin, and aniline-violet, must be dissolved in three parts of alcohol before they are added to the hardening fluid, whilst others, such as fuchsin and aniline-red can be dissolved direct. Very beautiful preparations are made by colouring the fluid with picrocarmine or borax-carmine.

To get rid of the sediment produced by these agents the fluid must be filtered before the ova are laid in it. For washing, 5 per cent. alcohol is first used (5 hours), then ordinary alcohol (10 hours), and then absolute alcohol; for clearing, oil of cloves; and for mounting, Canada balsam.

By the second method the ova are hardened and cut, and the section placed on the slide wetted with one or two drops of coloured oil of cloves. In 5–10 minutes the latter is sucked away with filtering paper. The oil can be coloured with eosin dissolved in alcohol or with safranin.

If *entire ova* or embryos are freed from their outer albuminous coat and hardened, then taken out of the alcohol, left free until the alcohol is evaporated, and then wetted with a few drops of oil of cloves or turpentine, very excellent and *stable* preparations are obtained for the study of the outer segmentation.

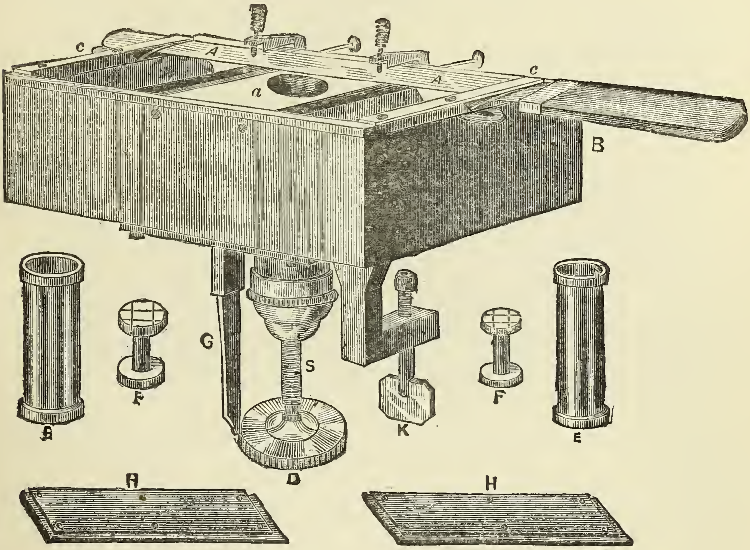
Satterthwaite and Hunt's Freezing Section-cutter.*—Dr. T. E. Satterthwaite, in conjunction with Dr. J. H. Hunt, has devised a modification of the ordinary freezing microtome, shown in Fig. 134.

It consists of the brass cylinder S, made of rather large size and placed in the centre of a metallic box B. The length of the cylinder, with milled head D, is about 5 inches. The diameter of the well *a* is $1\frac{3}{8}$ inch. Fitted round the cylinder is a plate glass for the knife to sweep over.

* Satterthwaite, T. E., 'A Manual of Histology.' 478 pp. and 198 figs., 8vo, London, 1881.

The knife A A is large, measuring 13 inches in length, including handle and $1\frac{3}{8}$ inches in breadth. It is slightly concave on both sides, and is fitted into a brass frame *c, c*, $7\frac{1}{4}$ inches by $3\frac{1}{8}$ inches. Two

FIG. 134.



strong brass springs and two sliding clamps hold it in place. The knife and frame are modifications of Dr. Curtis's plan.

The well is so large that it will hold an ordinary kidney after hardening, or, at least, so much of it that a section may be made of the whole organ at one sweep of the knife.

Each revolution of the milled head raises the preparation $\frac{1}{31}$ inch, and as it is divided into 30 divisions, each division represents $\frac{1}{930}$ inch. G is an indicator for marking the thickness of the sections, E E are tubes to fit in well, F F plugs, H H covers to the box, and K a binding screw to attach the latter to a table.

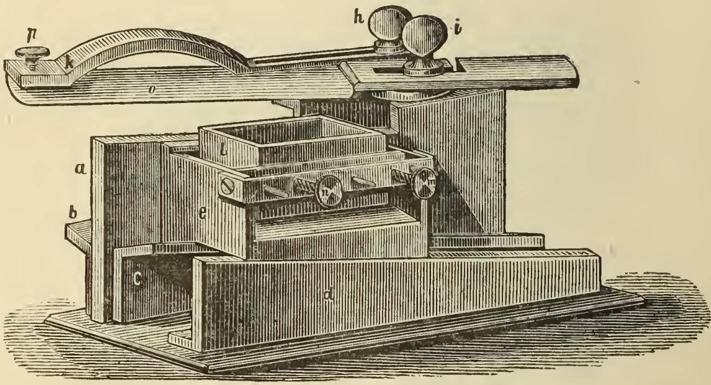
Windler's Microtome.* — This (Fig. 135) is a modification of Rivet's microtome, but retains little more than the principle of the original, i.e. the inclined (*c d*) and horizontal (*b*) slides attached to the vertical plate (*a*), these parts being all of metal. Instead of the ordinary clamp, which is very unsuitable for delicate objects, the inclined slide on the left supports a brass slide *e*, the under surface of which is lined with lead. Metal cases of different sizes *l* for the object to be cut, can be placed within it, and fixed by the screws *n*.

* Bericht wiss. Instrumente Berliner Gewerbeausstellung im Jahre 1879 (L. Loewenberg, 1880) pp. 309–12 (2 figs.).

The elevation of the slide as it is pushed forward can be read off on a scale on the vertical plate and a nonius.

The knife *o* is attached to a slide *f* (Fig. 136), which has an eccentric disk *g* on its upper surface. By turning this disk the knife,

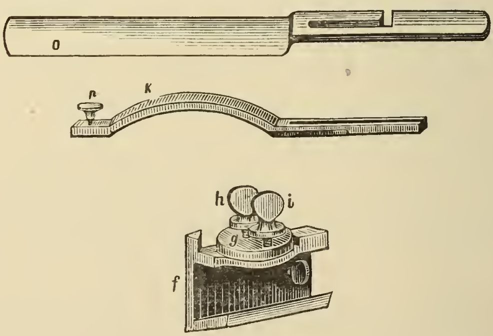
Fig. 135.



which is fixed by the clamp-screw *i*, can be brought into any desired position.

There is one defect in all sliding microtomes, which consists in the tendency of the knife, when fastened only at the handle, to give

Fig. 136.



way at the free end of the blade on any resistance in the object. This defect is remedied by the metal bow *k*, the slit end of which passes through the axial screw *h*, while the front portion is attached to the knife by the screw *p*, by which means any displacement of the end of the blade is prevented.

Marsh's Section Knife.* — It is frequently suggested that the surface of the knife which has to glide along the cutting-plate of the

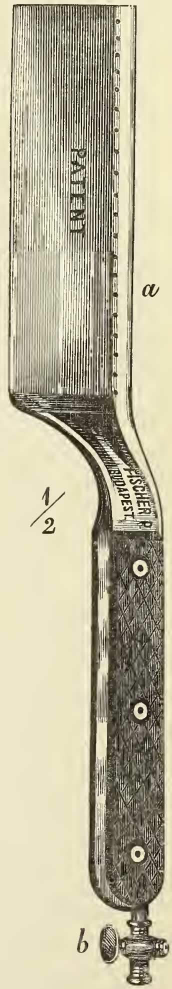
* 'Microscopical Section-cutting,' 2nd edition, 1882, pp. 32–3 (2 figs.).

microtome should be ground *flat*. This Dr. S. Marsh considers to be a most unsuitable arrangement, as a very little actual experience of section-cutting will speedily demonstrate. After many unsuccessful attempts to obtain a really good and reliable section-knife, he had one made, which has proved everything that could be desired.

Fig. 137.

Fig. 138.

Fig. 139.



The knife is shown in Figs. 137 and 138, the latter being a transverse section of the blade. It is furnished with a blade 4 inches long and $\frac{7}{8}$ inch broad, set in a square handle of boxwood, also 4 inches in length. The thickness of the blade at the back is not quite a $\frac{1}{4}$ inch, while *both* of the surfaces are ground slightly hollow. It is essentially necessary that the back and edge of the blade be strictly parallel to each other; that is to say, the edge must form a straight line, and both the edge and under side of the back must lie in the same plane, otherwise the knife, when in use, will have such a tendency to tilt over as to render its management extremely difficult. It is very easy to discover if this condition be fulfilled, for if, on carefully laying the flat of the blade upon a piece of level glass, every portion of both back and edge are found to be in close contact with it, the knife may in this respect be considered perfect.

Thanhoffer's Irrigation Knife.* — This (Fig. 139) devised by Professor L. v. Thanhoffer, and adapted either for free-hand cutting or with a hand microtome, consists of a blade (wedge-shaped in section) 11 cm. long and $2\frac{1}{2}$ cm. broad, a handle $12\frac{1}{2}$ cm. long and $1\frac{1}{2}$ cm. broad, and a tube (a b) for supplying water to the blade. This tube is attached to the back of the blade, and is there pierced with a row of fine holes; it also traverses the handle and terminates at its butt-end in a tap, to which an indiarubber tube may be attached. The fixed tube is supplied by the indiarubber feeding-tube with water from a vessel placed on a higher level or from a water-main. The water comes out of the small holes in drops

* Arch. Mikr. Anat., xix. (1881) pp. 315–7 (1 fig.).

and flowing together covers the blade with a layer of water along its whole length, even when it is lightly smeared with oil or has become greasy from the imbedding mass. It should, however, be kept in a horizontal position, or better somewhat inclined to ensure the water flowing over it. A vessel is placed under the hand to catch the water and also the sections which can be floated off by its aid, an important advantage of the instrument. If very large sections are required, the tube should not be directly attached to the blade, but a few millimetres above it. The section can then be floated off between the tube and the blade.

Differential Staining of Nucleated Blood-corpuscles.* — It has been urged against the differential staining of histological structures, that the process may induce an alteration which may be mistaken for the normal condition. That this is, in many cases, true, is beyond question, but Dr. A. Y. Moore considers that the exceptions are far too numerous to justify it as a rule. For some years past he has used a process for the double staining of nucleated blood-corpuscles, which causes no alteration, except of course in colour, and as the structure can be seen much better in a semi-transparent than in a more perfectly transparent body, the corpuscles thus stained offer advantages for study which are not found in those left unstained.

The fluids used for this purpose are two, viz.:—A. Eosin, 5 grains; distilled water, 4 drachms; alcohol, 4 drachms. Dissolve the eosin in the water and add the alcohol. B. Methyl-anilin green, 5 grains; distilled water, 1 ounce.

The blood should be spread upon the slide, by placing a drop upon one end and quickly drawing the smooth edge of another slide over it. This, if well done, will leave a single layer of corpuscles evenly spread over the central part of the slide. When the corpuscles on the slide are thoroughly dry, which will only require a few minutes, the slide should be "flooded" with stain A. This should be allowed to remain on for about three minutes, at the end of which time, it may be washed by gently waving back and forth in a glass of clean water. Before it is allowed to dry, the corpuscles should be again flooded, this time with stain B. After two minutes' exposure to this fluid, the slide should be washed, as before, and set away to dry. When dry, a drop of Canada balsam may be put upon the blood, a cover-glass applied and the whole gently warmed until the balsam spreads out properly. When hard it may be finished the same as is usual with balsam mounts.

If now examined with the Microscope, the corpuscles will be found to be well stained with red, while the nuclei and "leucocytes" will be a bluish-green. The granular appearance which is ordinarily seen in the nuclei, now shows with a vigour and sharpness which is difficult of description, while the whole corpuscle is as brilliant as a newly-cut ruby.

The Editors of 'The Microscope' (which since its commencement has contained much valuable matter), call special attention to the

* 'The Microscope,' ii. (1882) pp. 73–6 (1 col. pl.).

above method, working microscopists having long sought after a double-staining process for blood-corpuscles in which Dr. Moore is the first to succeed.

Flemming's Modified Method for Staining Nuclei.*—A method was published in 1875 by G. E. Hermann,† consisting essentially in overstaining with anilin or azotized staining matters, and subsequently extracting the colour, except from the nuclei, by means of absolute alcohol.

On this W. Flemming suggests some improvements. He finds the nitrogenized colouring-matters better than anilin colours for the purpose. Chromic acid is also preferable to alcohol for hardening, as it preserves the characters of the nuclei with more certainty. The preparations are fixed in chromic acid of ·1 to ·5 per cent. according to their nature. Only sections or thin, flat, and readily penetrable pieces should be used, and they must be thoroughly washed in distilled water. They are then placed for 12 to 24 hours in closed vessels in about 1 ccm. of a solution of safranin (or one of the other colouring matters mentioned below) absolute alcohol being used diluted by about the same amount of distilled water.‡ The object is now transferred to alcohol which frees it from part of the colour by shaking for a short time, and then into absolute alcohol and moved about for half a minute or more until no more colour is given off, and the object appears transparent and of the desired tint. If the object is to be permanently mounted it is placed in oil of cloves, but only so long as will admit of the tissue becoming penetrated, as it draws out the colour, and then mounted in cold dammar solution or balsam.

Out of a series of colours which were tested, *mauvein* and *fluorescent red*, while staining the nuclei well, are yet somewhat unequal in their action in that some nuclei will retain more colour than the rest. *Solid green* has the property of being very readily extracted from the intermediate substance of the nucleus, leaving the fibrillar network of the latter well stained. If this is decolorized, the nucleoli long retain the colour. *Fuchsin* gives excellent colours but somewhat paler than safranin, magdala, dahlia, and mauvein. *Bismarck brown* is unsuitable for the above process with chromic acid. *Safranin*, *magdala-red* (or naphthalin-rose), and *dahlia* (monophenylrosanilin) are the most constant and satisfactory in their action.

It must be noted, however, that practically the only application of the method is for nuclei-staining in chromic acid preparations. Where, however, it is desired to preserve and readily investigate the true natural structure in cell-nuclei and divisions of nuclei (which

* Arch. f. Mikr. Anat., xix. (1881) p. 317–30.

† Flemming subsequently stated (tom. cit., pp. 742–3) that the credit of priority so far as regards nuclei-staining with anilin colours, and decolorizing with alcohol, is due to Professor Böttcher, whose method is not, however, to be recommended for the same purposes as Hermann's, as he uses Müller's fluid and alcohol, stains the sections with a solution of rosanilin-nitrate in dilute glycerine, and after extracting the water with alcohol, clarifies with creosote.

‡ Dahlia is best used in aqueous or acetic acid solutions.

succeeds best with chromic acid), the above process is to be preferred to all others. The only alternative method is hæmatoxylin, and that is much more uncertain in its action.

Iodine-green for Human and Animal Tissues.*—Dr. H. Griesbach recommends as the most useful of all anilin staining materials for this purpose, a new green material, tetramethylrosanilinmethyliodide, or "iodine green," or "Hofmann's green." The composition of the solution for staining is preferably 0·1 gr. crystallized iodine green, and 35 gr. distilled water, though it may be varied according to the tint required. The hardened tissue is placed for a few seconds in distilled water and then in the staining fluid, the action being almost momentary. After washing in distilled water it is transferred to glycerine or absolute alcohol, cleared in oil of cloves or aniseed, and mounted in Canada balsam or dammar.

The objection to other anilin colours, that alcohol often draws the colour completely out in a few minutes, scarcely applies to iodine green, which is much more resistant. Its chief advantages, however, are its rapid action, which adapts it excellently for demonstrations, and the fact that it also often gives different tints of the same colour to different parts of the tissues. For instance in a section of the uterus of a deer, the epithelium is blue, the tubular glands dark green, the cylindrical ciliated cells of the single tubes show a splendid colouring of their nuclei, the longitudinal musculature is malachite green, and the connective tissue remains uncoloured. Hardened objects colour better than fresh. Connective tissues and bones are not coloured at all or only very slightly. Glandular organs, hardened in alcohol, are excellent objects. The gland-cells are distinguished from the membrana propria by an intense and uniform colour. Striated muscle (in alcohol preparations) is coloured a cantharides green, the sarcolemma remaining uncoloured. Iodine green is also very useful for blood-corpuscles of vertebrates and invertebrates, for human white blood-corpuscles, and all kinds of isolated cells, spermatozoids, bacteria, &c. Also for ganglion-cells and axis-cylinder. In a section through human spinal cord in a chromic acid preparation (after a brief treatment with absolute alcohol and rinsing in distilled water) the horns of the grey substance were immediately coloured a uniform green, the *substantia gelatinosa* the same but brighter, the *substantia alba* being uncoloured. This is an additional advantage of iodine green as it is well known with what difficulty chromic acid preparations take certain colours.

Professor Kollmann's statement of his satisfactory experiences with iodine green is added.

Teichmann's Injection-mass.†—The exact proportions of the materials used by L. Teichmann for his injection-mass‡ are as follows:—

Red mass:—Prepared chalk 5 gr., vermilion 1 gr., linseed oil

* Zool. Anzeig., v. (1882) pp. 406–10.

† Abh. and SB. Naturw. Kl. Akad. Krakau, vii. (1880) pp. 108. Cf. Jahresber. Anat. u. Physiol., ix. (1881) pp. 11–12.

‡ Described generally in this Journal, *ante*, p. 125.

·9 to 1 cub. cm., carbon disulphide ·75 cub. cm. For the injection of entire subjects by the aorta Teichmann uses first of all a thinner mass consisting of chalk, 500 gr., vermilion 100 gr., linseed oil 120 cub. cm., carbon disulphide 150 cub. cm.; he then employs a stiffer preparation of chalk 1000 gr., vermilion 200 gr., linseed oil 200 cub. cm., carbon disulphide 100 cub. cm. *White masses*, especially adapted for injection of lymphatics, have the following composition:—Zinc white 20 gr., linseed oil 3 cub. cm., ether 2 cub. cm. By addition of colouring matters this mixture forms other combinations. The following proportions are in general suitable for a *blue mass:* Zinc white 15 gr., ultramarine 1 gr., linseed oil 2 to $2\frac{1}{2}$ cub. cm., carbon disulphide 1 cub. cm. The injection is made slowly by a syringe, the piston of which is provided with a screw-thread and is pushed gradually forwards by a twisting movement. The linseed oil is first boiled for eight to ten hours, and no lead compounds are added to it.

Wywodzen's Injecting Material.*—D. Wywodzen has, he says, obtained admirable results by using thymol. The proportions are:—thymol 5 parts, alcohol 45, glycerine 2160, and distilled water 1080.

Mounting in Pure Balsam.†—Dr. S. Marsh, although he cannot too strongly insist upon the use of benzol-balsam wherever practicable, yet points out that it sometimes happens in the mounting of substances of considerable thickness that, after all the benzol has evaporated, an insufficient amount of balsam is left behind to fill up the cavity between slide and cover. In such cases, therefore, it is advisable to use pure balsam, which may be done in the following manner:—The object having been previously thoroughly dehydrated by immersion in absolute alcohol, it is to be thence transferred to a little *good* turpentine or benzol, where it should remain until perfectly transparent. It is now to be placed in the centre of a slide which has been gently warmed, and a drop or two of fresh fluid balsam added, the greatest care being taken to prevent the formation of air-bubbles. Should such arise they must be touched with the point of a heated needle, which will cause them to burst and disappear. The chief difficulty of the process has yet to be encountered in the application of the cover, for it is during this procedure that the development of air-bubbles is most likely to take place. This annoyance may, however, be entirely avoided by taking the simple precaution of dipping the cover into turpentine before it is applied, when it will be found that "you can't get air-bubbles even if you try." The author adds that it is to the courtesy of Mr. J. A. Kay, late of Chatham, that he is able to give his readers the benefit of this practical "wrinkle."

Centering Objects on the Slide.‡—Dr. Marsh considers that the appearance of a slide is vastly improved if the preparation be placed

* St. Petersb. Med. Wochenschrift, No. 51. Cf. Jahresber. Virchow and Hirsch for 1880, p. 2.

† 'Microscopical Section-cutting,' 2nd ed., 1882, p. 109.

‡ Ibid., p. 101.

exactly in its centre. This may readily be done in the following manner:—Take some very finely-powdered Prussian blue and rub it up in a mortar with a little weak mucilage, so as to form a thin blue pigment. A quantity of this should be made so as always to be at hand. A slide having been cleaned, the *best surface* is to be selected, and on the reverse side, by means of a self-centering turntable, a small circle is to be drawn with a camel's-hair pencil charged with the pigment. In the centre of this ring, but on the opposite side of the slide, the section is to be placed, when it, of course, will occupy a position exactly central. When the slide comes to be finished, the blue ring may easily be removed with a wet cloth.

Chalk Cells.*—For dry mounting of diatoms, and objects not much exceeding $\frac{1}{50}$ of an inch in thickness, Mr. F. Kitton has been using cells prepared in the following manner:—Wash some whitening in water to get rid of the coarser parts (foraminifera, sponge-spicules, &c.), or levigated chalk as sold by druggists can be used, and make a mixture about the consistency of cream with weak gum water; three or more applications will make cells of a sufficient depth. When dry go over them two or three times with a solution of Canada balsam dissolved in benzine. The cells should not be used until the balsam is quite hard; then place the cover (upon which the diatoms ought to be mounted) in position, and with a heated slide press it upon the cell; when properly attached the cement ring can be made in the usual manner.

Line and Pattern Mounting.†—Mr. H. Sharp gives the following directions for this kind of mounting, his slides thus prepared being said by Mr. W. H. Wooster to be "exquisite examples of manipulative skill."

"*Requisites*:—(1) One or two cat's or mouse's whiskers fastened on match-like sticks or fine rushes, with shellac rather than gum, with about $\frac{1}{4}$ inch free. I prefer to have one with the natural point, and another with the point cut back to where it is somewhat stiffer. (2) A good simple Microscope of some kind, either attached to a roomy stage-plate, with a mirror below and revolving plate above, or detached on some stand, but capable of being brought over a mounting table with mirror and rotating plate as above. My own is home-made, extremely simple, costing nothing but the trouble, and such as any one with a little ingenuity could make for himself. It consists of a piece of pine 9 inches long, 5 inches wide, and 1 inch thick, on three legs, with a hole in the centre, into which a wooden matchbox (with the bottom cut out) fits tightly, projecting a little above; over this fits a piece of slate just tight enough to rotate easily; beneath, a peg receives the mirror of the Microscope. This forms the detached mounting table. For the simple Microscope, I take the foot and tube pillar of the condenser, fit a piece of cane in this tube, drive a pickle-bottle cork stiffly on it, and fasten on this a horizontal wooden bar with a hole in the middle to fit on the cane, and another at each end

* Amer. Mon. Micr. Journ., iii. (1882) pp. 151–2.
† Journ. Micr. Soc. Victoria, i. (1882) pp. 94–6.

in which to fit the lenses, which are just the $1\frac{1}{2}$-inch and $\frac{1}{2}$-inch objectives, which give far better definition than common pocket lenses. (3) A steady hand. (4) Patience and perseverance.

Dry Mounts.—All diatoms and scales should be mounted on the cover, not the slide. Lay a clean cover on a slide and keep it in place by a drop of water between. As scales are larger than diatoms, it is well to begin with them. Put several on a slide in the ordinary way, pick out the ones wanted with a bristle under the simple Microscope, one at a time; keep the cover flooded with moisture from the breath, and deposit the scales picked up wherever wanted in lines or patterns. They will readily leave the bristle for the wet glass, and can be pushed about quite easily. When the moisture dries off no stain is left, and the objects will adhere with sufficient firmness to resist anything short of a sharp jar. When the line or pattern is finished, mount in a shallow cement cell.

Balsam Mounts.—The cover must have a film of a gelatinous nature which is insoluble in balsam and its solvents. A thin aqueous solution of isinglass carefully filtered serves well. A single drop is placed on a clean cover, and spread out as thin as possible with a clean needle. It dries almost instantly in warm weather, and in a few seconds in winter. A diatom placed on this film and *gently breathed on* is securely sealed, and cannot be dislodged without moisture. Care must be taken to place the diatom in position while the film is quite dry; then breathe on it; allow the film to dry again; then place another diatom, and so on till the line or pattern is finished. If any of the diatoms are thick or likely to be crushed, stick three bits of cover-glass under the edge of the cover with gum, and place a dot of gum on each before placing the cover in position on the slide. This, when dry, will keep the cover in its place while introducing the balsam, before doing which allow a little benzine to run under by capillary attraction, which soon displaces the air from the diatoms. Then apply a little balsam to the edge of the cover and a bit of blotting-paper to the opposite edge. This draws away the benzine, and the balsam follows and takes its place. Another plan is to gum a piece of good cream-laid paper on the slide, centre on the turntable, and make two cuts through the paper, removing the middle and outer portions and leaving a ring of paper to form a cell as large as the cover; then cut two small openings in opposite sides of the ring, gum the top of the cell and insert the prepared cover on the gummed surface. When dry apply benzine to one of the small 'sluice gates,' and then balsam as before. Put the slide in a warm place for several days, and finish off with white, black, or coloured varnish to fancy. Winter is the best time for dry mounts, as the breath dries off too soon in hot weather; and summer is the best time for the balsam mounts, as it is difficult in the winter to keep the breath from moistening the isinglass at the wrong time. The cement cells should be quite dry and hard before mounting, or a dewiness will appear and ruin the object. Soften the cement over the lamp, press the cover down till it sticks all round, let stand a day or two, and finish off. No doubt the diatoms would be more secure if burnt

on the cover in the dry mounts, and possibly that process would be sufficient for the balsam mounts without the film of isinglass, as stated on p. 68 of Davies' 'Manual of Mounting.'"

Mr. Sharp has tried several kinds of mechanical finger, but declares he "can do the work quite as well and in less than half the time" by the method described above.

Mr. W. M. Bale also discusses * the subject of mounting diatoms in symmetrical groups in continuation of a previous paper † in which he described the process for valves which are very small and flat, and are to be mounted dry. Large or uneven diatoms are, however, liable to leave the slide at the least jar, and must therefore be attached with some cement; while *any* diatoms which are to be mounted in balsam must be fixed to the slide or cover with a cement not soluble in the turpentine contained therein. In these cases, a minute drop of clear gum may be deposited near the centre of a clean slide, and thinned with a drop or two of water, the whole being spread backwards and forwards over the slide with the blade of a knife till none appears to be left in the centre where the objects are to be placed. The diatoms are then arranged on the slide in the usual manner after breathing on it, and when dry they will adhere to its surface, after which they may be covered in the ordinary way. With dry mounts especial care must be taken that the merest invisible film of gum remains on the slide, the appearance of the diatoms being spoiled if they are saturated with gum or any similar material.

For transferring valves from one slide to another mounted bristles are best, one rather stout for large diatoms, and another not thicker than a human hair, and somewhat curved for lifting small valves and remaining particles of dust. Bristles are, however, too elastic for moving the diatoms into the exact position, for which a fine needle is almost indispensable.

When the objects are to be mounted in balsam, the slide should be allowed to dry, and a small drop of carbolic acid placed on the diatoms, which are then to be examined with the Microscope, as it frequently happens that the gum, if not thin enough, seals up the minute cells in the valve, or even the whole cavity beneath it, preventing the entrance of the acid. In this case a drop of spirits of wine placed on the diatoms will usually find speedy entrance and dispel all bubbles, and while the diatoms are still wet with the spirit the carbolic acid may be placed upon them. Gentle warmth will then evaporate the spirit, leaving the acid, and it only remains to apply a small drop of balsam and a cover, taking care, if any of the valves are very convex, to provide rests to prevent the cover from crushing them. It is better to let the balsam fall on the diatoms than to apply the cover first, and let it run in, as it very often carries in with it particles of dust, cotton fibres, &c., which may be on the slide or the edge of the cover, and which are apt to come in contact with the diatoms and remain there. The running-in process is only necessary when the valves are not cemented to the slide, and when,

* Journ. Micr. Soc. Victoria, i. (1882) pp. 97–9.
† Ibid., i. (1881).

consequently, balsam let fall on them would be almost certain to disperse them.

In most cases it is advantageous to mount the diatoms on the cover, which is easily done by first fastening it to a slide with a drop of glycerine, which will not evaporate during the process of mounting, and is easily removed afterwards. Large diatoms, such as *Arachnoidiscus*, when mounted on the slide and examined by reflected light, are apt to show a slight haze surrounding the group, instead of the intense black ground which should be presented when all light is shut off from below the stage. This is caused by reflection from the under surface of the slide, and can be avoided by mounting on the cover and placing some dead-black material at the bottom of the cell.

If Polycistina or Foraminifera are to be mounted, a thicker layer of gum should be placed on the slide than for diatoms, as these objects, from their peculiar forms, have usually a very small part of their surface in contact with the slide.

The author considers "this branch of microscopic art as quite legitimate" where selected species have to be mounted and provided scientific value is not sacrificed to mere prettiness. He also says that he has recently used the gum process with all balsam-mounted diatoms even when they are not arranged symmetrically for the sake of the security it affords against the valves being displaced by slight pressure on the cover-glass, or by the slide being kept in other than a horizontal position, also for the advantage of being able to mount the valves in different positions so often necessary in order to get an exact idea of their true form.

Kain's and Sidle's Mechanical Fingers.*—Mr. C. H. Kain describes a simple mechanical finger for use with any Microscope that has the fine adjustment on the nose-piece. It is designed to obviate the inconvenience of the one described by Professor H. L. Smith,† which requires the loosening and tightening of the objective for the purpose of focussing.

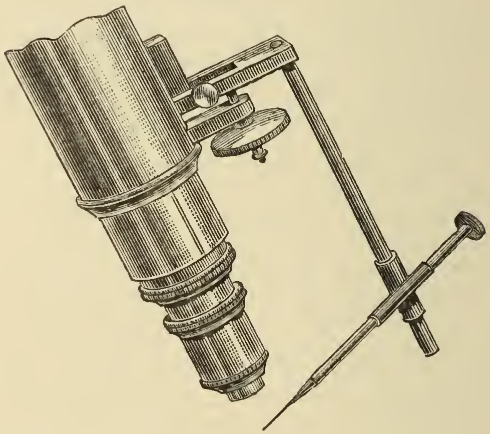
It consists essentially of a slotted bar (Fig. 140), which may be firmly clamped to the upper (immovable) bar of the fine adjustment by means of a milled-headed screw. Through the end of this is fastened a round rod, at such a distance from the objective that, when lowered, the end will not strike the stage. Over this rod slips a split tube, to which is soldered, at an angle, a smaller tube. Through the small tube passes a rod carrying a glass thread at its extremity. This rod is easily rotated by means of a milled head. The capillary glass thread is attached to the extremity by means of beeswax. There is no revolving collar, as it is quite unnecessary, especially when the Microscope is provided with a revolving stage. By dispensing with the revolving collar and making all movements depend entirely upon the adjustments of the Microscope, greater stability and accuracy in working are secured.

* Amer. Journ. Micr., vi. (1881) pp. 149–51 (1 fig.).
† See this Journal, ii. (1879) p. 952.

The author says:—

"To use the finger, the point of the glass thread is first brought into the focus of the objective, or nearly so, by sliding the tube on the vertical rod, and pushing or pulling the rod carrying the thread until the desired position is attained. It is not difficult to do this,

Fig. 140.



and having once been done by hand, it does not have to be repeated, as all further movements are made by the adjustments of the Microscope. Supposing now the point of the glass thread to be in focus; by means of the fine adjustment throw the focus *ahead* of the point, then, by means of the coarse adjustment, rack down and search for the object you wish to pick up. Having found the object desired, again bring the point of the thread into focus by means of the fine adjustment; then rack down with the coarse adjustment and pick it up. Now rack back with the coarse adjustment, remove the slip on which the material is spread, and place your prepared slip or cover upon the stage. Again, by means of the fine adjustment, throw the focus ahead of the object, rack down with the coarse adjustment, and search for the spot where you wish to deposit the object, and having found it, again focus the object, then rack down with the coarse adjustment, and when the object touches the slide and has been placed in proper position, fix it by means of a very gentle breath. I prefer this mode of fixing instead of the arrangement of tubes proposed by Professor Smith.

I coat the surface of the cover or slide upon which the diatoms are to be fixed with an exceedingly thin film of gelatine, prepared thus:—Dissolve 2 drachms of Cox's gelatine in 10 drachms of acetic acid by the aid of a gentle heat. When the gelatine is thoroughly dissolved, add 1 drachm of alcohol and 1 oz. of distilled water; stir well until thoroughly mixed, let stand some hours, and filter through the finest filtering paper. Keep in a glass-stoppered bottle. To coat

the cover or slip I dip a small needle in the solution and wipe it once flatwise across the glass.

There are many little wrinkles which the worker will acquire from time to time. One of the most important of these is the art of using the finger as a lever for moving diatoms or other objects into position when very slight movements are necessary. To do this, move the slide by hand until the point of the finger is just behind the object to be moved; then, by racking down with the coarse adjustment, the glass point pushes the object ahead of it. By a succession of pushes the object may be moved into any desired position. The coarse adjustment may be used in a similar manner for turning diatoms on edge or upside down, by pushing them against some fixed object and forcing the glass point under them. By using a point rather firmer than usual, the valves of a diatom may be separated. To do this I usually fasten the diatom on a slide which has been coated with gelatine, and when it is firmly fixed, the upper valve may be punched off without much difficulty.

Another wrinkle, and quite a valuable one too, is what might be called a scientific use of the imagination. Many cannot work a mechanical finger well without an erecting eye-piece, on account of all movements appearing to be reversed. This difficulty will disappear if the worker will just imagine, as he holds the stage and moves it, that he is holding the finger and moving it; all motions will then appear to be perfectly natural. I might state here that a mechanical stage is not the best for this kind of work.

There is a popular misconception in regard to the mechanical finger which it may not be amiss to mention. Many regard it as a kind of scientific plaything—an instrument used merely for arranging diatoms so as to form pretty slides. I have no doubt but that it will come eventually to be regarded as one of the microscopist's most valuable accessories, and one which every worker will require. It may be used not only in handling and studying diatoms, but also other objects which are too small to be handled in the ordinary way. In studying the Infusoria, for instance, a drop of water containing them may be placed in a concave slide, then, when the water has been almost evaporated, or has been removed by means of bibulous paper, the Infusoria may be picked out with the mechanical finger and studied, or deposited on a slip for mounting. A firm thread of dark-coloured glass is best for this.

In studying diatoms, a mechanical finger is almost indispensable, for it may safely be said that one is not thoroughly acquainted with a diatom until he has turned it over and viewed it in all its aspects. In mounting diatoms for study it is well to mount a number of the same kind in various positions, so as to display the various spines, undulations, or other peculiarities. How often it happens, too, that in a mixed gathering of diatoms—and it is not easy to obtain pure gatherings—we find a rare frustule which we should like to preserve. By means of a mechanical finger the frustule may at once be selected and mounted.

When one wishes to arrange diatoms so as to form symmetrical

figures, an eye-piece micrometer will be found very useful, not only in selecting diatoms of uniform size, but also in determining their position. A circle ruled in squares and used in the same way as the eye-piece micrometer will be found still more desirable. It is a good idea to keep a number of glass points, of different degrees of fineness, ready prepared; that is, attached to little rolls of beeswax, so that if a point is unsuited for a particular work another can be substituted in a moment."

Messrs. Sidle have also modified the mechanical finger described *ante*, Vol. II. (1879) p. 952, by adding a micrometer-screw with a milled-head nut for moving the point of the glass thread in and out of focus, thus avoiding unscrewing the front of the objective. The sliding rod has been retained for getting it approximately into position. By a later improvement the glass "hair" or bristle is carried on a second rod through a sleeve attached to the first or vertical one, nearly at right angles. Thus, by the rotation of the second rod, and of the entire apparatus around the axis of the Microscope, the diatom may be brought into any desired position.

Venice Turpentine as a Cement.*—Professor C. B. Parker says that his attention was called to a substance known in the Pathological Laboratory, at Vienna, as *Venedischer Damarlack* (Venetian dammar varnish), which was exclusively used for sealing and finishing glycerine mounts. No such substance is known to the American trade, but he found after experimenting that Venice turpentine, prepared as presently to be described, if not identical, at least answers every purpose equally as well. The following are the directions for preparing the turpentine. Dissolve true Venice turpentine in enough alcohol, so that after solution it will pass readily through a filter, and, after filtering, place in an evaporating dish, and by means of a sand bath evaporate down to about three-quarters of the quantity originally used. The best way to tell when the evaporation has gone far enough, is to drop some of the melted turpentine, after it is evaporated down to about three-quarters its original volume, into cold water, and on being taken out of the water if it is hard, and breaks with a vitreous fracture on being struck with the point of a knife, cease evaporation and allow to cool.

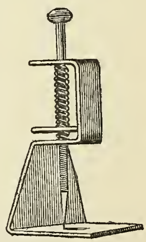
Square covers should be used, and the cover-glass being adjusted with the usual precautions observed in glycerine mounting, the surplus glycerine, if any, should be wiped away, and the slide so placed that the edges of the cover-glass are plainly seen. A piece of wire, No. 10–12 (copper is the best, as it gives to the turpentine a greenish tinge), is bent at right angles, the short arm being just the length of the cover-glass. The wire is heated in the flame of an alcohol lamp, and plunged into the prepared turpentine, some of which adheres to it. The wire is then brought down flat upon the slide at the margin of the cover, and the turpentine will distribute itself evenly along the entire side of the cover. The same process is to be carried out on each of the other three sides. Any little unevenness may be removed by passing the heated wire over it.

* Amer. Mon. Micr. Journ., ii. (1881) pp. 229–30.

The advantages claimed for this substance, over all others used for a similar purpose, are that it is secure. Such thick objects as the female organs of *Vermicularis* and *Tricocephalus dispar* in glycerine, are now as tight and firm as when first mounted in 1878. It hardens immediately. The moment the heated wire is removed, the specimen may be cleaned and handled without fear, a great advantage over such slow-drying fluids as dammar and balsam. It never runs in, as white zinc and other cements are apt to do.

Metal Caps for Glycerine Mounts.* — Mr. F. Enock protects objects mounted in fluid from damage by external pressure by a small metallic ring of angular section fitting closely round the outside of the cell and at the same time slightly overlapping the cover-glass, entirely closing in the rim. He writes: — "I have had much bitter experience with preparations mounted in glycerine, which suffer injury from clumsiness in handling, more than the fault of expansion; for after a preparation has been mounted two or three years, the cement becomes very hard, and if injured by a fall, or knock against the Microscope, starts a leak. The number of preparations ruined by my customers in this and other ways, prompted me to find a remedy, or to lessen the chance of injury. I have now devised the metal caps, which so far have stood the heavy thumps of the Post-office men, and all the clumsy treatment which many give them. The caps are made to fit Pumphrey's vulcanite cells, as they are the only cell to be depended upon for size and shape. I never use any other. My plan of using these caps is as follows:—After having fixed the cover properly and without leakage, I wash the preparation under the tap until all traces of glycerine are removed, then run a good thick ring of any kind of cement round the edge of the cover and cell, finally dropping on the cap, when the mount should be placed aside for a week, so that the cement or varnish may properly set. I use these caps for all deep cells, as they prevent the cover from being pushed off, and am having some made half the depth of those sent, for shallow cells."

Fig. 141.



Nassau Adjustable Spiral Spring Clip.—This clip, the construction of which is sufficiently explained by Fig. 141, can be instantly adjusted by a screw movement to any degree of pressure required upon the cover-glass in mounting.

Green Light for Microscopical Observations.—We briefly alluded to this subject in the previous volume,† but it may be well to record somewhat more specifically that Professor T. W. Engelmann strongly recommends the use of green light for delicate observations; it not only spares the eyes, but also gives images which are markedly sharper than

* North. Microscopist, i. (1881) pp. 297–8. Journ. Quek. Micr. Club, i. (1882) p. 40.
† This Journal, i. (1881) p. 224.

those given by white light. Blue light is less to be recommended, and red is altogether to be rejected.

M. Flesch* points out the disadvantage of green glass for light modifiers, as it absorbs the red rays almost completely, so that the colouring in carmine preparations is not visible, and that of other parts of the objects becomes indistinct.

Photo-Micrography.†—Professor C. H. Kain doubts "whether microscopists in general are fully aware of the extent to which late improvements in dry-plate photography have simplified the work. To the investigating microscopist it is almost absolutely essential to be able to permanently preserve the results of his observations. This is usually done by the aid of the camera lucida, and the zealous worker will often sit for hours with his eye fixed at the instrument laboriously striving to represent an object, and if he is not well skilled in the use of the pencil his labour is frequently almost useless, so inaccurate is the result. By far the greater part of this labour may be saved, at an expense so trifling, and with results so satisfactory, that he thinks the time is at hand when every working microscopist will regard a dry-plate photographic outfit as a necessary part of his equipment.

"The wet-plate process is cumbersome, and not well adapted to the wants of the microscopist, but the dry plates now in the market are admirable, not only for their great sensitiveness and beautiful results, but also for the ease with which they can be manipulated. They can be purchased so cheaply, that it can scarcely pay the microscopist to prepare them himself. Some of the great advantages which they possess are the following:—

"1. They can be kept for any length of time and used as occasion requires.

"2. If not convenient to develope the plate at the time the exposure is made, it can be put away and developed at leisure even after an interval of weeks.

"3. No dangerously poisonous chemicals are necessary in the developing process.

"4. They are so sensitive that the light of an ordinary kerosene lamp (preferably a student lamp) is amply sufficient to photograph objects with all powers not higher than $\frac{1}{2}$-inch objectives." Probably a $\frac{1}{4}$-inch objective could be used by properly arranging a system of condensers.

The author adds: "As some who desire to experiment in this line may require a starting-point as regards the matter of exposure, I would say that with the light of a student lamp, and using a single condenser, I have found that from $1\frac{1}{2}$ to $2\frac{1}{2}$ minutes with a 2-inch, $2\frac{1}{2}$ to 5 with a 1-inch, and 4 to 7 minutes with a $\frac{1}{2}$-inch objective are about the proper times when the A eye-piece is in and using what are known as Carbutt's rapid (B) plates, No. 468. When the eye-

* SB. Phys.-Med. Gesell. Würzburg, 1882 (sep. repr.).
† Amer. Mon. Micr. Journ., iii. (1882) pp. 71–2.

piece is not used about one-half of that time is required. Of course the time of exposure will vary somewhat according to the density or transparency of the object, and if stained, according to the character of the colouring matter."

At a meeting of the Camden (U.S.A.) Microscopical Society,* Mr. J. Carbutt took a negative from a spider's foot with a 2-inch objective and an exposure of 2 minutes, and from a sheep's tick with an exposure of $1\frac{1}{4}$ minute, the shorter exposure being due to the object being much less dense and yellow. "B" dry plates were used in both cases.

Woodward's Photographs of Amphipleura and Pleurosigma.—It will be remembered that Dr. J. J. Woodward forwarded to the Society, in illustration of papers by him,† fourteen photographs of *Amphipleura pellucida*, and three of *Pleurosigma angulatum*.

As these photographs are not generally accessible, it may be useful to note that they were reproduced by a heliographic process (on a scale of $\frac{1}{3}$) in the 'Arch. f. Mikr. Anat.'‡ which is to be found in many libraries in this country. The plates are accompanied by an abstract of Dr. Woodward's papers by C. Janisch.

Microscopical Examination of Handwriting.—Dr. J. H. Wythe, of San Francisco, maintains, as we have already recorded,§ that every man's handwriting is infallibly distinguished by three characteristics, that may be detected by the Microscope while they escape the eye, viz.:—rhythm of *form*, dependent on habit or organization; rhythm of *progress*, or the involuntary rhythm, seen as a wavy line or irregular margin of the letters; and rhythm of *pressure*, or alternation of light and dark strokes. The proper microscopical examination of these three rhythms, under a sufficient illumination of the letters, cannot fail, he believes, to demonstrate the difference between a genuine and an imitated signature.

Professor D. T. Ames,‖ while believing Dr. Wythe's views to be sound, "prefers to more simply define the three characteristics as *habit of form, movement, and shade;* these, in connection with other attendant peculiarities of handwriting, furnish a basis sufficient to enable a skilful examiner of writing to demonstrate the identity of any handwriting with a great degree of certainty.

"In extreme cases, and especially skilfully forged signatures, the aid of the Microscope will be necessary for a proper examination, but for the greater proportion of cases of questioned handwriting a common glass, magnifying from ten to twenty diameters, will serve much the better purpose, as it is amply sufficient to reveal the characteristics of the writing, while its greater convenience of use and broader field of view are greatly in its favour.

"In the writing of every adult are habits of form, movement, and

* See 'The Microscope,' ii. (1882) pp. 43–4.
† See this Journal, ii. (1879) pp. 663–74, 675–6.
‡ Arch. f. Mikr. Anat., xviii. (1880) pp. 260–70.
§ See this Journal, i. (1881) p. 856.
‖ 'Penman's Art Journal.' See Amer. Journ. Micr., vi. (1881) p. 214.

shade, so multitudinous as in the main to be unnoted by the writer, and impossible of perception by any imitator. Hence, in cases of forged or imitated writing, the forger labours under two insuperable difficulties, viz. the incorporation of all the habitual characteristics of the writing he would simulate, and the avoidance of all his own unconscious writing habit, to do which in any extended writing we believe to be utterly impossible.

"How far this inevitable failure may be discovered and demonstrated depends upon the skill of the forger, and the acuteness of the expert."

Examination of Sputa.*—In suspected cases of phthisis where it is very desirable to know the progress made by the disease, great aid may be procured by an examination of the sputa of the patient. It is now a recognized fact that phthisis has been diagnosed, and is diagnosed in this way, weeks and months before other signs are manifested.

As expectorated ingredients in the sputa, one finds remains of food, starch-granules, epithelium, air-bubbles, mucus-cells, pus-cells, blood-corpuscles, large granular cells, and, perhaps, pigment-cells. If now besides these are found fragments of lung tissue, as yellow elastic fibres, it shows that there must be a disintegration of the pulmonary tissue, a condition which must denote serious trouble. If these fibres are not found it does not by any means prove that serious trouble may not exist, but their presence is very significant.

If the patient is in the habit of using tobacco, it should be denied during the collection of the sputa, as the fibres of the leaf might mislead and cause a wrong diagnosis. If the amount of sputa is small, then all raised during the twenty-four hours should be saved. If large, that first raised in the morning should be preferred. Any little greyish masses should be chosen and placed at once under the Microscope. Acetic acid will clear up the mucus, &c., and render more distinct the yellow fibres if they are present. If this examination reveals nothing, the following method should be adopted:

Make a solution of sodic hydrate, 20 grains to the ounce of water. Mix the sputa with an equal bulk of this solution and boil. Then add to this mixture four or five times its bulk of cold water. If possible, pour into a conical-shaped glass and set aside. Soon the yellow fibres, if present, will fall to the bottom; from where they can be drawn up with a pipette and examined. Several slides should be examined at a single sitting, and the examination should be repeated every few days until the presence or absence of these fibres is satisfactorily demonstrated.

Trichina-Examinations.—The microscopical examination of pork for *Trichinæ* is, as is well known, obligatory in many parts of the Continent. In Germany in particular such an inspection is encouraged pecuniarily and punishment awarded in case of negligence.

* Cincinnati Med. News, x. (1881) pp. 550–1.

An inspector was, in 1874, sentenced to six weeks' imprisonment for having overlooked the presence of *Trichinæ* in an animal which he had inspected. In Italy also pork is similarly examined.

We subjoin a copy of an official notice on the subject of such examinations.*

Official Notice.—*Directions for the Microscopist in the Examination of the Flesh of Pigs for Trichinæ.*—1. Approved physicians, veterinary surgeons, and apothecaries are without examination officially admitted as microscopists on application to the city magistrate according to the demand for their services, such appointment being revocable; other persons are only admitted after undergoing an examination as to their fitness before the royal district physician.

2. Every microscopist must have a Microscope, the efficiency of which has been examined by the royal district physician, and its lowest power must not be under 40 nor over 60 diameters. A Microscope which has not been examined or which has been found unserviceable may not be used for Trichinæ examinations.

3. The microscopists are appointed to certain districts, and are bound to undertake in their districts, or in those for which they are temporarily appointed as auxiliaries, examinations when required and without any delay, between the hours of 6 in the morning and 8 in the evening, from the 21st March to the 21st September, and between 8 in the morning and 8 in the evening from the 21st September to the 21st March.

4. The samples of flesh to be used for examination are to be taken from six places in the case of whole pigs, viz.:—

(1) From both sides.
 (*a*) From the eyes, or the masticatory muscles.
 (*b*) From the diaphragm.
(2) From one side.
 (*a*) From the muscles of the larynx or the loins and stomach.
 (*b*) From the intercostal muscles, in single portions of flesh and hams, to be taken from at least two places by the microscopist himself.

From each sample of flesh at least five preparations which can be put under a covering glass are to be prepared.

5. The result of the examination is to be entered by the microscopist, with his name and the date added, under the proper heading in the flesh-book, which the butcher has to keep. To private persons he has to give the certificate prescribed by § 4 of the Trichinæ examination regulations.

6. If a pig or a portion of one is found to be trichinous, the same must be guarded from being changed by a plain mark set upon it. Notice must be given immediately to the royal district physician, and the preparation in question produced to him for subsequent revision; immediate notice is also to be given to the police authorities.

* Zeitschr. f. mikr. Fleischschau, i. (1880) pp. 124–5.

7. The microscopist must keep a book in which he shall enter the examinations made by him in the following form:

1	2	3	4	5	6	7
Consecutive No.	Date when slaughtered.	Description of the pig examined, as to sex and age, or specification of the part of flesh examined.	Name and residence of the party who brought the animal to be slaughtered, or who gave the order.	Day and hour of the microscopical examination.	Attestation of the microscopist as to the result of the microscopical examination with respect to Trichinæ and flukes.	Remarks.

If flukes or anything else prejudicial to the use of the flesh for food is found to exist, immediate notice thereof is to be given to the police authorities, and a report made in the form of columns 6 and 7.

8. Hams or pieces of pork examined must always be marked with a brand. Whole animals are to be branded in different parts of the skin when it is required by the owner.

9. A microscopist may not undertake in one day more than twenty examinations of whole pigs. The examination of three hams and three pieces of pork are reckoned, for the purpose of examination, as equivalent to one whole pig.

10. If any case of evasion of microscopical examination becomes known to the microscopist, he must give notice to the police authorities.

Fees payable for examining pigs for Trichinæ.—By virtue of § 8 of the local police regulations for the microscopical examination of pigs' flesh for Trichinæ, the fees payable to the microscopist are hereby fixed until further notice, and shall be as follows:—

1. For examining a pig	1 mark (= 1s.)
2. When several pigs are examined at the same time in one and the same place, for the first animal	1 mark.
For every subsequent ditto . . .	70 pf.
3. For a piece of pork or a ham	30 pf.
For examining at the same time several pieces of pork or hams in the same place:	
For the first piece	30 pf.
For every additional piece . . .	20 pf.
The minimum charge, however, for the examination of only one or two pieces of flesh or hams when not taken to the dwelling of the microscopist shall be . .	70 pf.

Some of the regulations are more elaborate than the preceding, those for Silesia, for instance, occupying twelve pages,* and including regulations for the examination of candidates, and instructions as to making and examining the preparation, and using the Microscope. The latter are as follows:—

* See Wolff, E., 'Die Untersuchung des Fleisches auf Trichinen,' pp. 14–15. 74 pp., 1 pl. and 2 figs., 6th ed., 8vo, Breslau, 1880.

"The tube of the Microscope must be tested each time before it is used to see whether any foreign body is enclosed in it, or one of the diaphragm stops has got on edge. The draw-tube must be pulled out before use. The glasses of the lens-systems of the instrument, and also the illuminating mirror, are to be carefully cleaned with a dry hair-pencil, or with very soft wash-leather.

With illumination by light from below, care must always be taken that it falls as horizontally as possible on the mirror. The Microscope should therefore not be brought nearer to the window than is absolutely necessary. Dazzling sunlight is a disadvantage. Double windows are an impediment to the examination.

Only in exceptional cases are examinations to be made by lamp-light, and on such occasions a low petroleum lamp is to be used, with a glass shade, the lower part of which is closed either by porcelain-glass or ground white glass.

Those who desire to examine with low powers and light from above must bring the Microscope near the window in order to obtain as much incident light as possible.

The hours of bright daylight are to be chosen for the examination, and the work should be done, if practicable, at an open window.

The greatest care must be used in attaching to the tube the systems selected, and the operator must make sure that the tube is exactly centered. Particular attention must be given to the estimation of the focal distance. With low powers the focal distances are much greater than with high-power objectives, and the tube will therefore require a greater distance between it and the preparation, in proportion as the powers used are low.

The preparation to be examined is now placed, with the cover-glass on, in such a position on the stage that it lies as nearly as possible over the centre of the opening of the stage. The largest diaphragm aperture is then to be brought underneath, and full direct light reflected by the mirror up the tube. Whilst the eye, kept as near as possible to the eye-piece, is directed towards the object, the tube is cautiously moved up and down till the image appears clearly."

The Prefect of the Seine has also recently established a course of six lectures for the teaching of micrography, and an examination has been instituted for inspectors for detecting Trichinæ in the substance of pork and ham of American or German origin imported into France.

Continuous Observations of Minute Animalcula.*—E. Holmes having found some difficulty in keeping minute living objects under observation on account of the water evaporating, and also that any attempt at a supply produced currents which washed away all very small organisms, was led to put upon a slide a small quantity of water, and a very minute portion of plant, not using enough water to occupy all the space under the cover-glass, but leaving part of it occupied by air. A ring of paraffin wax was put round the cover, thus sealing up the contents, embracing rotifers and diatoms, several hundred species in all. At the expiration of a week they were still

* Sci.-Gossip, 1882, p. 138.

alive. The same process tried on *Cyclops quadricornis* (only with a shallow cell to contain a depth of water just enough not to squeeze the creature betwixt slip and cover) allowed young *Cyclops* to hatch out of the eggs in each instance some dozens in number, and very active, the old and young doing well at the end of forty-eight hours. The author adds:—" Obviously if one finds a rare minute creature, and wishes to send it to a friend for inspection, one may seal it up in this way without the risk, or it may be, certainty of losing it involved in placing it in a tube. It will live comfortably enough during transmission by post, or during the few hours required to carry it to the meeting of a society, or a friend's house. It is even safer in transmission, because the quantity of water used is not enough to shake about as it will in tubes or small bottles, and half a day's fishing to find it again is dispensed with, as it is sure to be on the slide."

Microscopical Examination of Textile Fabrics.*—Prof. C. Cramer has paid special attention to the detection of adulterations of the three following kinds in textile fibres.

1. Detection of Chinese grass (*Boehmeria nivea*) in silk. In floss-silk containing adulteration to the extent of from 50 to 75 per cent., ordinary chemical tests are unable to detect the nature of the admixture. Microscopical and microchemical examination prove the presence in the silk of bundles of bast-fibres of *Boehmeria nivea*, which are snow-white, shining and rigid, in contrast to the yellow and more flexible threads of silk. They are at most 18 cm. in length, while the silk threads are much longer; the diameter of the latter varying between 0·0076 and 0·0214 mm., that of the former between 0·0061 and 0·00643 mm. The natural ends of the bast-fibres are finely pointed, of the silk threads abruptly broken. The bast-fibres have a cavity, sometimes too small to be measured, but varying to a width of 0·055 mm.; silk is solid and homogeneous. The walls of the former are swollen and knotted in places, exhibiting in sulphuric acid clear longitudinal striæ; silk has nothing of the kind. In polarized light the bast-fibres show bright colours in the middle and at the margin; the polarization colours of silk are dull and not visible in the middle. In addition, the bast-fibres readily take fire; are not coloured yellow by nitric acid, while silk is; remain white when warmed with Millon's reagent, silk becoming red; with iodine and sulphuric acid they turn a copper-red, violet, or indigo-blue colour, accompanied by swelling, while silk becomes golden-yellow or brown; and boiling with concentrated soda-ley does not attack the bast-fibres; this last test being used to determine the extent of the adulteration.

2. Detection of shoddy in woollen fabrics. In a specimen of blue cloth, the wool having been removed by potash-ley, were found vegetable adulterations, consisting of unconnected bast-fibres, and thickish branched and anastomosing bundles of bast-cells 0·006 to 0·015 mm. in thickness, and not more than 0·2 to 0·65 mm. in length. These

* Cramer, C., 'Drei gerichtliche mikroskopische Expertisen betreffend Textile-Fasern.' 29 pp., Zürich, 1881.

last are derived from the fruits of various species of *Medicago*, especially *M. apiculata*, *denticulata*, and *Tenoriana*. The unconnected bast-fibres are probably from the leaves and epidermis of the stem of *Gyncrium argenteum*, the most abundant grass in the pastures of Uruguay, Buenos Ayres, Paraguay, and Entre Rios, from which the wool may have come. The animal fibres were entirely wool.

3. Distinction between fibres of hemp and flax. The bast-cells of hemp and flax present no character by which they can be distinguished with certainty under the Microscope, even with the assistance of reagents. The bast-cells of flax are slightly more slender, but this cannot be relied on. A transverse section of both is usually circular, but occasionally polyhedral or flattened, and the size of the cavity affords no certain criterion. The formation of layers is slightly more obvious in hemp; but the difference is too small for practical use. The pores described by Schacht and Wiesner are believed by Cramer to be transverse folds of peripheral layers of cell-wall. Both fibres are coloured blue by iodine and sulphuric acid; ammonio-oxide of copper causes appearances of swelling in both. Hemp-fibres are not always coloured yellow by sulphate of anilin. The best distinctive character of the two fibres is the substances which accidentally accompany them. The parenchyma which surrounds hemp-bast contains numerous crescent-shaped clusters of crystals of calcium oxalate, which the bast-parenchyma of flax does not. Among the bast-cells of hemp are also elongated cells widened tangentially, filled with an intensely red-brown endochrome, sometimes composed of connected ribbon-shaped masses, sometimes broken up into quadrangular pieces, insoluble in boiling potash, cold alcohol, ether, turpentine-oil, and benzin, offering long-continued resistance to concentrated sulphuric and hydrochloric acids, and rendered colourless by Schulz's solution. The epidermis of the two plants also presents differences. That of flax has numerous stomata and no hairs; that of hemp few stomata and unicellular hairs thickened in a warty manner. These characters are always easy of detection.

The Microscope in Engineering Work.*—The following is a paper by R. Grimshaw, read at a meeting of the Franklin Institute.

"The specimens shown are intended to outline a method of using the Microscope as an aid to the testing machine in estimating the value of structural materials. While it is not intended to suggest that the Microscope will determine definitely the elastic limit, nor even the breaking strain of structural materials, it is designed to convey very distinctly the idea that the Microscope may be used for preliminary investigations which will determine whether or not the material is good enough to warrant its being tried on the testing machine. If the Microscope condemns the material, it is not worth while going to the expense of having it tested by more expensive methods. If the Microscope fails to reveal any flaw, then the material may be sent to the testing machine to be further proved. The larger the specimens that would be required for testing in the machine, the more marked

* Journ. of the Franklin Institute, cxiv. (1882) pp. 173–5.

the advantage of the Microscope in saving, in the case of specimens readily determined to be bad, the expense of further testing, and the risk of using it in construction. The samples shown this evening are of bridge timbers, and the lesson they are intended to convey is that had this method of examination been followed, the material which was proved to be faulty after being built into the bridge, would have been promptly thrown out. The samples shown were photographed by Mr. W. E. Partridge, of New York, a professional engineer who is an enthusiastic amateur photographer, and to whom I am indebted for the particulars concerning them.

The timber from which the poor specimens were taken came in the form of a chip broken off when a highway bridge was wrecked in 1879–80. The timber formed a portion of the sill of a draw-bridge, which consisted of two 12-inch sticks, lying one on the other. The turntable casting having been somewhat too small, this 24-inch timber had to support one of the A frames of the bridge at a distance of about twelve inches outside of the bed-plate. After a few days of service, while an empty truck was passing over, the strain became so great that the A frame sheared the 24-inch sill, wrecking the whole bridge. The timber was so exceedingly poor that upon mounting it on the Microscope the porous and weak nature of its structure was at once discovered. Its annular rings are something like three times the distance apart which would be found in a piece of thoroughly good wood of a similar character. The medullary rays are few in number and short in length, while in good wood they are of considerable length, and so numerous that the tangential sections appear like a series of tubes seen endwise, or a number of parallel chains. After once seeing and comparing two samples of wood it is very easy to recognize their characteristic features by the use of a pocket magnifying glass.

The trunks and limbs of exogenous trees are built up of concentric rings or layers of woody fibre, which are held together by radial plates, acting like the trenails of a wooden vessel, or the "bonds" in a brick or stone wall. The rings or layers representing successive years' growths, are composed of tubes, the interstices between which are also filled with cellulose. The slower the growth of a tree the thinner these yearly layers, and the denser and harder the wood, other things being equal. This is true as between one kind of tree and another, and also between different individuals of the same kind.

Not only is the closeness of the growth an indication of the hardness and strength of the timber, but the size, frequency, and regularity of distribution of the radial plates which bind the layers together may be taken as a very close illustration or sign of the character of the wood and its ability to resist strain, especially that from crushing stress.

The micro-photographs of the sections of good and bad timber show that in the strong specimens the concentric rings are close in texture and of light width; and the radial plates frequent, wide, long, and thick, while in the poor material, the reverse characteristics are shown.

The lesson to be learned from these microphotographs is that having proper views of transverse and radial lengthwise sections, and of sections perpendicular to a radius, of a standard piece of timber resisting certain standard or minimum strains, all timber having fewer rings per inch of tree diameter, fewer fibres, and fewer and shorter radial plates per square inch of section, should be rejected as not up to the standard, and applied for other purposes or used with a greater factor of safety.

This method has the advantage of enabling every stick of timber in a bridge to be inspected and judged, and is offered as an interesting and valuable aid to the breaking tests made by the machine.

In this connection I may offer as the parallel in metal-work two portions of pure Lake copper, one an ingot as ordinarily found, in which the grain is coarse and crystalline, the colour dark red, and the mass full of blow-holes; this is an average sample of copper casting. The other is run from the same pig, at the same heat, and in a similar mould, but with proper precautions to prevent oxidization; in consequence, there are no blow-holes, the grain is close and fine like that of the best bronzes, and the colour is salmon, which is the true copper colour. The "deoxidized" casting weighs 25 per cent. more than the ordinary casting from the same pattern, calipering the same. For these I am indebted to the Philadelphia Smelting Works, Twelfth and Noble Streets.

Tests made of the deoxidized copper rolled into sheets ·035 inch thick showed on strips 2 inches wide a tensile strain of 33,760 lbs. per square inch, ordinary fine copper in sheets being quoted by Trautwine at 30,000 lbs. This would show 12·5 per cent. superiority in the metal having the fine fracture. No. 20 "deoxidized" wire shows a calculated tensile strength of 45,000 lbs. per square inch, and still later tests of wire of the same thickness showed a calculated tensile strain of 41,056 lbs. per square inch for the ordinary, and 47,552 lbs. for the deoxidized, a striking confirmation of the indications of the Microscope."

The Microscope in Metallurgy.—A paper on this subject by M. Atwood was recently read before the San Francisco Microscopical Society.

In a former paper on "The Microscope in Geology," the author remarked that the Microscope in mining would soon become as important an instrument in guiding the miner in his operations as the compass was to the navigator, as only by the aid of the Microscope could be correctly determined what was so necessary for him to know, namely, the true character of the inclosing rocks of the different metalliferous veins he was either prospecting or working, and thereby rendering mining a less hazardous undertaking, and not allow the art to degenerate into a mere "trial-all" system. We are now only beginning, in the author's view, to understand and realize the great value of the Microscope in metallurgy. One of its most important uses, however, and to which he more especially calls attention, is in the milling of gold quartz, where it has aided in distinguishing and proving in the most unmistakable manner the true condition of the

gold in iron pyrites, which we now know to exist in a metallic state, being therefore only mechanically mixed with the iron pyrites, so that the amalgamation of the gold in the raw ore can be easily effected, and with little loss, if ordinary precautions are taken to have the ore reduced fine enough to liberate the gold enclosed in the finer particles of pyrites. Mr. Atwood procured samples of pyrites from most of the mining counties of this State, and made a careful microscopical examination of them, the result confirming in every respect the conclusions of Daintree and Latta published in Australia in 1874.

The paper was illustrated with several mounted specimens. One slide showed the gold on a crystal of pyrites, which, with the aid of an inch objective, was seen as a beautiful gilding on some of the planes of cleavage. Another slide showed the gold in little drops, also filling some of the small cavities. Still another showed the gold in little specks, imbedded in the pyrites. Another specimen disclosed the gold in fine specks or scales mixed with the sesquioxide of iron. Mr. Atwood has found that in the examination of all metals good bright daylight should, if possible, be used. The specimens, as seen by lamplight, did not exhibit the gilding as well as it was seen in the daytime.

Micro-Chemical Methods for Mineral Analysis.*—T. H. Behrens publishes a very full paper on this subject, commencing with an historical account of the origin and progress of micro-mineralogical methods, and with a detailed description of his "new micro-chemical method."

If, he says, the number of micro-chemical reactions which are at the disposal of the microscopist in the subject of petrography is much smaller, and their application is much more limited than in the microscopical anatomy of plant and animal tissues, the reason is certainly not that less advantage may be expected from the examination of the rocks by such methods. If in felspar the potassium and calcium could be detected with the same ease and certainty and their quantity appropriately ascertained, as is done in the case of starch by means of iodine, and of cellulose by means of iodine and sulphuric acid, how much petrography would be advanced by such a method of examination will be evident to most microscopists.

Endeavours were early made to extend the means of determining the constituents of rocks. Zirkel first examined his rock sections in ordinary light, then in polarized light, and in 1868–70 he introduced hydrochloric acid as a reagent to distinguish between decomposable and undecomposable minerals in basalt, viz. labrador from oligoclase and magnetite from titanic iron. Since then this acid has had its use extended, but only in a few cases were the products of the reaction subjected to examination, thus the formation of carbonic acid, of sodium chloride and of gelatinous silica, capable of taking up colouring matters, were used to demonstrate the presence of calcite, nepheline and decomposable silicates as olivine, chlorite, &c., respectively. Other micro-chemical reactions are the detection of apatite by a nitric acid

* Versl. en Mededeel. K. Akad. Wetensch, xvii. (1881) pp. 27–73 (1 pl.).

solution of ammonium molybdate, of the minerals of the hauyn group by means of sulphur vapour, and of opal by means of a magenta solution.

In the meanwhile the methods of optical examination were being greatly improved; the use of gypsum and quartz plates for increasing the double refraction, determining the depolarizing directions, and distinguishing between positive and negative double refraction, were borrowed in a complete form from the accessories of zoologists and botanists; through Tschermak the test of dichroism was applied (1869), and through Descloizeaux the stauroscope of Von Kobell was added (1875). The now tolerably complete instrumental methods were united by Rosenbusch in a convenient form (1876), and rapidly made known by his treatise on the whole subject. New cutting and polishing machines, Microscopes, and accessories were afterwards introduced, and principally from the workshops of Fuess, in Berlin, and Seibert, in Wetzlar. The advantages of the purely optical method of examination are that with a compact apparatus and without any damage to the preparation, it can be examined and determined quickly, and in comparison, simply, in a way impossible with hand specimens. The physical properties at first relied on for the discrimination of minerals, and then replaced by Werner and Mohs for the chemical properties, have again, although under altered conditions, become of primary importance in modern micro-mineralogy and micro-petrography. Unevenness of the faces and partial opacity ("milkiness, muddiness"), which interfere so greatly with the use of the goniometer, polariscope, and stauroscope, are removed by the use of thin sections, or nearly so; cleavage directions, which otherwise have to be sought for with a hammer and chisel, are at once detected; crystal enclosures can only be completely studied under the Microscope, and their constant occurrence in certain mineral species affords a new means of detecting such species, i.e. hauyn, noseau, leucite, quartz, garnet, &c. The success obtained by clever observers by these methods during the last fifteen years has been such as to place on a new basis the study of rocks, but even in these methods much practice is necessary, while in not a few cases, especially where decomposition has set in, in spite of all endeavours deductions can only be regarded with uncertainty.

The method of acting on a rock powder with hydrochloric acid, and examining before and after treatment mounted in balsam, is not a very successful one. The solution of the soluble part can indeed be filtered off and chemically examined, but the uncertainties still remain considerable. E. Bořicky was the first to make known a connected system of micro-chemical reactions, he excludes filtration, and his method is simple. It depends on the action of hydrofluosilicic, or of hydrofluoric acid on small fragments of the mineral or on the rock section itself, the separation of crystalline silicofluorides by evaporation, and the recognition of the several compounds by their form under a magnifying power of 200–400 diams.

But though the method is capable of rendering service in some cases, yet in others it is very insufficient, and there are considerable

difficulties connected with it. Examples of these difficulties are:—the time required for the reaction, the formation of gelatinous pulverulent white crusts of aluminium silicofluorides which hide the minute crystals of the other silicofluorides, especially the very transparent sodium salt, and then the calcium, iron, magnesium, and other fluosilicates are very soluble, and crystallize only when the solution dries up completely. Owing to these difficulties, and the want of methods for detecting silica and alumina, the author was led to look for other methods more convenient, quicker, and having a wider application.

Preparation of the Test Sample.—If the individuals composing the rock are larger than 1·5 mm., then small fragments may be broken from splinters of the rock by means of a pair of pliers; their homogeneous nature is tested by a lens, or a low power under the Microscope. If the rock is of a finer grain it must be crushed and the dust removed; using a low power small fragments of any of the constituents may now be picked out for examination. If the constituents are such as not to be readily distinguished from each other, when coarsely powdered, a section must be made of the rock, but no thinner than is necessary to give sufficient transparency for examination under a magnifying power of a hundred diameters; the top surface of the section may be either slightly polished or smeared with glycerine or oil. The balsam is softened by a gentle heat, and the required fragments picked out under the Microscope with a needle or knife, using a low power and a high eye-piece, and freed by ignition from balsam, &c. The selected fragments are ground in an agate mortar. They are brought into solution by means of a very little fuming hydrofluoric acid, or of ammonium fluoride and strong hydrochloric acid (this is done in a small platinum spoon) and then gently evaporated to dryness; the residue is moistened with a small quantity of dilute sulphuric acid and heated till most of the free sulphuric acid is removed. Water is then added, and the whole gently boiled until but little more than one drop remains. This solution of the sulphates is taken up by a capillary glass tube of 0·2 mm. diam., and in this manner divided and placed on slides for examination by the tests for the various substances. The solutions are examined without cover-glass, since it allows of better and quicker working; the objective is protected by a small plate of mica fastened on with a drop of glycerine, a power of 150–250 diams. is most convenient. The weight of substance required is from 0·2 to 0·5 milligram.

Calcium.—If any considerable quantity is present gypsum begins to crystallize out at once in short prisms, or if in smaller quantity then after a few minutes as crystals of the usual form of gypsum, $\infty P . P . \infty P . \infty P . \acute{\infty} \acute{\infty}$. Mean size 0·060 mm. If but a trace of calcium is present it may be detected by allowing the drop to absorb a little alcohol vapour, the gypsum then separates in needles.

Potassium.—To the preceding test-drop is added a drop of platinum chloride solution, by means of a loop of platinum wire. The double salt soon separates; if not, it may be accelerated by the action of alcohol vapour. It forms very sharp light-yellow octahedrons, with

a high refractive index. Size 0·010–0·030 mm. The separation of the silico-fluoride is not so rapid, nor are the crystals nearly so easily recognized. The phosphomolybdate greatly resembles in colour and form the platinum double salt, but separates very much more slowly. Cerium sulphate quickly produces a precipitate of a double salt (see under Sodium).

Sodium.—The reagent used is a concentrated solution of cerium sulphate. If much sodium is expected place near the test-drop one of the reagent, and connect them by a small thread of glass, the latter drop then becomes turbid and under a power of 600 diameters is seen to contain whitish, translucent particles of scarcely 0·002 mm., and if potassium were present also larger spheroids greatly resembling potato starch, size 0·005–0·008 mm. If less than 1 per cent. of alkaline sulphate is supposed to be present, the two drops are at once allowed to touch each other, and the potassium salt forms in lumps, or occasionally in truncated rhombs, six or eight-sided, while the sodium salt forms short pointed prisms, like the Navicellia, size 0·003–0·005 mm. These are not to be confounded with crystals of the cerium sulphate itself, which have the same form, but are five or six times the size. Any great excess of sulphuric acid must be avoided. The separation of the sodium silico-fluoride is not so delicate (see under Fluorine).

Lithium.—After precipitating any lime present as gypsum, the lithium is thrown down by addition of an alkaline carbonate. The monoclinic crystals resemble those of gypsum, but are yet quite distinguishable, size 0·050–0·075 mm.; they are moreover distinguished by their solubility in dilute sulphuric acid. Crystalline magnesium double carbonates can only be formed if a large excess of alkaline carbonate is employed. Phosphoric acid may entirely prevent this test for lithium.

Barium and Strontium.—These exist as sulphates in the insoluble residue left in the platinum spoon. The residue is heated with concentrated sulphuric acid, and the solution brought by a capillary pipette on to a slide. On cooling and absorbing water the crystalline sulphates separate. Barium sulphate forms small crossed lens-shaped crystals, size 0·005–0·012 mm. Strontium sulphate separates after the barium salt, the crystals likewise form crosses, but are distinguished by their greater complexity and size, viz. 0·020–0·045 mm. If much calcium is present in the mineral, gypsum crystals will be formed, they appear last of all, and in their usual forms. Lead would also appear here, the crystals have the same size as those of barium sulphate, but the form of strontium sulphate.

Magnesium.—To the test-drop is added a little ammonium chloride and ammonia until alkaline, and left a minute or two for any iron and manganese present to oxidize. At one cm. from this drop is placed a drop of water containing a fragment of microcosmic salt, the two drops are connected by a thread or two of glass. The crystals are very characteristic, being hemimorphous, if formed quickly peculiar skeleton growths of 0·060 mm. result, but if formed slowly only well-defined crystals of 0·010–0·020 mm.

Aluminium.—After long searching a very satisfactory reagent was found in cæsium chloride. A platinum wire is dipped into the concentrated solution, and the test-drop stirred with it, brilliant octahedrons of cæsium alum rapidly form, varying in size from 0·035 to 0·090 mm. The presence of iron has no effect.

Iron and Manganese can be so easily detected by ordinary methods that no special microscopic method is required.

Sulphur requires to be converted into an alkaline sulphate; sulphides are fused with nitre and sodium carbonate, insoluble sulphates with sodium carbonate. The coarsely powdered fusion is put in a drop of water; near it is placed a drop containing aluminium chloride, hydrochloric acid, and cæsium chloride; on connecting the two drops with a thread of glass the formation of cæsium alum shows the presence of sulphur.

Phosphorus and Arsenic.—These are brought into a soluble form by fusion with sodium carbonate, or with addition of nitre if arsenides may be present. A concentrated solution of ammonium chloride is added to the test-drop, and close by side of this is a drop of water containing a particle of magnesium sulphate (see further under Magnesium). The ammonium magnesium phosphate is not to be distinguished in form from the arsenate; addition of silver nitrate or of sulphuretted hydrogen affords no satisfactory distinguishing test. If it is required to test for both, the substance is to be fused with cyanide of potassium and carbonate of sodium in a narrow tube, the arsenic sublimes as metal and the residue containing only the phosphorus is tested as above. The test with ammonium molybdate solution is less satisfactory than that with magnesium sulphate.

Chlorine cannot be detected by silver nitrate, as the precipitate under the Microscope has no characteristic appearance. Mercurous or lead nitrate are more suitable, but have disadvantages; thallium sulphate is the best reagent. The test is heated with an excess of sulphuric acid in the platinum spoon and the hydrochloric acid gas evolved collected in a small drop of water hanging to a cover-glass, which is cooled by a larger drop of water on the top, and lies on the platinum spoon. The top drop of water is removed, the glass turned over and laid on a slide, and into the test drop is put a particle of thallium sulphate. The crystals of thallium chloride formed by any of these means are octahedrons with rhombic dodecahedrons, with a very strong refractive index, size 0·010–0·015 mm. The crystals are often grouped together in threes or fours, and then reach to 0·050–0·100 mm. Bromide of thallium is scarcely to be distinguished from the chloride, but the crystals of the iodide are distinguishable by their smallness, the largest rosettes measuring 0·020 mm., and by their intense yellow colour in reflected light; the fluoride is more soluble, has a somewhat different form, but appears very transparent and pale compared with the chloride.

Fluorine.—The test is first fused with soda—and silica if necessary—and then after addition of acetic acid evaporated to dryness; the residue is moistened with sulphuric acid and gently heated, the platinum spoon being covered with a concave lid of platinum foil, the

convex under side holding a drop of dilute sulphuric acid, the top some drops of cold water; after the reaction the cooling water is removed and the underneath drop put upon a varnished glass or a polished plate of barytes. Into the test-drop is put a little sodium chloride, beautiful six-rayed rosettes of 0·1 mm. form, then hexagonal plates and prisms with pyramids.

Silicon and Boron.—The following method allows of these two, i. e. supposing both to be present, to be separated and detected. The test is treated in the platinum spoon with a mixture of sulphuric and hydrofluoric acids, and heated very gently, silicon fluoride alone volatilizes and is collected and tested as under Fluorine. After addition of more hydrofluoric acid the heating is repeated but until fumes of sulphuric acid escape. The drop on the platinum cover is then evaporated to dryness at about 120°, the residue moistened after a minute or two with a drop of water, the solution brought on to a varnished glass, and a little potassium chloride added; potassium borofluoride separates in acute plates and rhombs, whose diameters are as 2 : 3, size 0·030–0·050 mm., the obtuse angles are sometimes replaced by edges. If no crystals separate at first, it is necessary for the drop to evaporate to dryness before making a conclusion.

Water is tested for by heating in a capillary tube as usual, with due precautions. The delicacy of the reaction may be increased by bringing into the tube a very little of the residue left by evaporating an alcoholic solution of magenta on glass; these thin skins are opaque and have a beetle-green lustre, on becoming moist they appear transparent and red.

The author is still occupied with finding suitable tests for some of the rarer elements, and with the more difficult task of finding reactions capable of being carried out on the rock section itself. A dozen examples are given of the applicability of the above methods; thus in 0·2 mgr. of sodalite were detected aluminium, calcium, potassium, and sodium, and in 0·1 mgr., chlorine; in 0·2 mgr. axinite were detected silicum, boron, aluminium, magnesium, and calcium; and in 0·3 mgr. apophyllite containing 1 per cent. fluorine, the latter was detected.

Microscopical Characters of Hailstones.*—A hailstorm at Innsbruck in September 1881, afforded J. Blaas an opportunity of examining the hailstones and determining the following results amongst others.

The opaque white layers which occurred in alternation with transparent ones and showed the appearance of radiating structure owing to the radial arrangement of the air-bubbles, never afforded any evidence that the crystalline elements were radiating in their arrangement; on the contrary, they were seen by the use of polarized light to consist of granules of ice, quite irregular in shape. The enclosed air-bubbles, some of which were of the smallest possible dimensions, had very irregular lobate forms, which always showed a

* Bote f. Tirol u. Vorarlberg, 1881, No. 215. Cf. Naturforscher, xiv. (1881) p. 454.

tendency to radiating arrangement. Among the substances inclosed were certain vacuolated masses, exactly similar to the drops of liquid found in crystals; they were very small, the vacuoles being very wide with dark margins. No movement was ever observed in the latter, but an argument in favour of their liquid nature is that as soon as (by melting) they are at the margin of the section of hailstone, they suddenly become empty, while the surrounding ice persists for a time. The exact nature of the other dirty and dust-like masses inclosed, which were by no means scarce, could not be determined.

Appearances presented by Air-bubbles and Fat-globules in White and Monochromatic Light.—We extract from Professor Ranvier's work on Histology,* the figures which illustrate the appearance at various points of the focus of an air-bubble in water and Canada balsam, and of a fat-globule in water, a diaphragm of about $\frac{2}{3}$ of a mm. being placed at a distance of 5 mm. beneath the stage, and the concave mirror exactly centered.

Air-bubbles in water.—Fig. 142, No. 1, represents the different appearances of an air-bubble in water. On focussing the objective to the middle of the bubble (B), the centre of the image is seen to be very bright, brighter than the rest of the field. It is surrounded by a greyish zone, and a somewhat broad black ring interrupted by one or more brighter circles. Round the black ring are again one or more concentric circles (of diffraction) brighter than the field.

On focussing to the bottom of the bubble (A), the central white circle diminishes and becomes brighter, its margin is sharper, and it is surrounded by a very broad black ring, which has on its periphery one or more diffraction circles.

When the objective is focussed to the upper surface of the bubble (C) the central circle increases in size, and is surrounded by a greater or less number of rings of various shades of grey, around which is again found a black ring, but narrower than those in the previous positions of the objective (A and B). The outer circles of diffraction are also much more numerous.

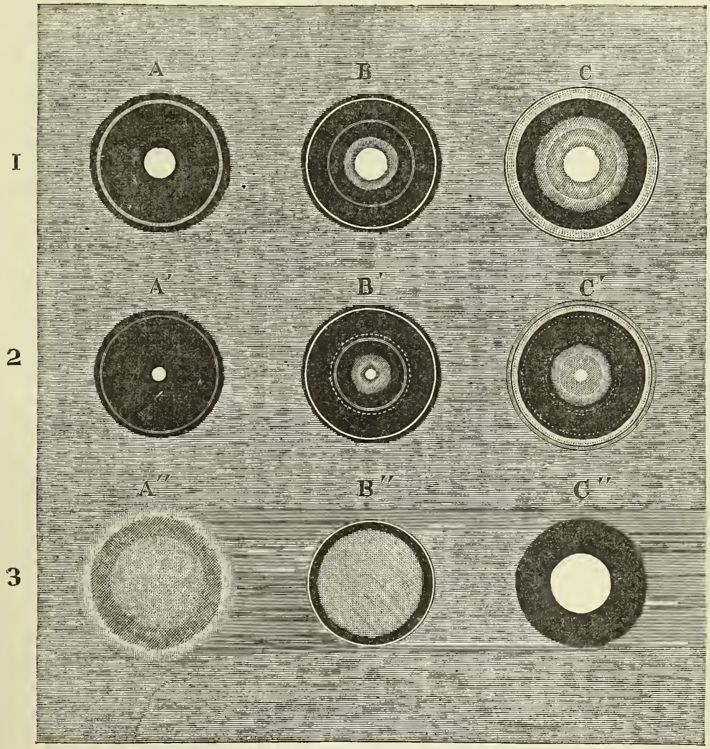
Professor Ranvier explains these appearances by reference to Fig. 143, which is a sectional view of an air-bubble (in water) receiving upon its base a series of parallel rays. The rays which passes through the centre of the bubble (undergoing no deviation) and those at a, a', a'' (which are more or less deflected by refraction) reach the eye of the observer, whilst a''' being incident at the limiting angle for rays which pass from water to air (48° 35′) is totally reflected, and does not reach the eye. The same is the case with the rays beyond a''', so that the margin of the bubble has a dark zone, varying as in Fig. 142, No. 1, A, B, C, according as the objective is focussed to the lower, central, or upper parts.

Air-bubbles in Canada Balsam.—Canada balsam being of a higher refractive index than water, the limiting angle instead of being 48° 35′ is 41° only, so that rays which are incident much less obliquely on the surface of separation undergo total reflection, and it will be

* Traité technique d'Histologie, 1878, pp. 14–20 (4 figs.).

only those rays which fall very close to the lower pole of the bubble that will reach the eye, and the black marginal zone will therefore be much larger.

FIG. 142.



This is shown in Fig. 142, No. 2. When the objective is focussed to the bottom of the bubble (A′), we have a small central circle, brighter than the rest of the field, all the rest of the bubble being black, with the exception of some peripheral diffraction rings. On focussing to the centre (B′) or upper part (C′) of the bubble, we have substantially the same appearances as in B and C, with the exception of the smaller size of the central circle.

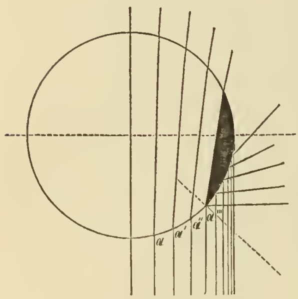
Fat-globules in water (Fig. 142, No. 3).—These illustrate the case of a highly refracting body in a medium of less refractive power.

When the objective is adjusted to the bottom of the globule A″, it appears as a grey disk a little darker than the field, and separated from the rest of the field by a darkish ring.

Focussing to the middle of the bubble (B″), the central disk becomes somewhat brighter, and is surrounded by a narrow black ring, bordered within and without by diffraction circles.

On further removing the objective the dark ring increases in size, and when the upper part of the objective is in focus, we have (C″) a small white central disk, brighter than the rest of the field, and sharply limited by a broad dark ring which is blacker towards the centre.

Fig. 143.



These appearances are the converse of those presented by the air-bubble. That, as we saw, has a black ring and a white centre, which are the sharper as the objective is approached to the lower pole of the bubble. The fat-globule has, however, a dark ring which is the broader, and a centre which is the sharper, according as the objective is brought nearer to the upper pole.

These considerations, apart from their enabling us to distinguish between air-bubbles and fat-globules, and preventing their being confounded with the histological elements, enable two general principles to be established, viz.—Bodies which are of greater refractive power than the surrounding medium, have a white centre which is sharper and smaller, and a black ring which is larger when the objective is withdrawn, whilst those which are of less refractive power have a centre which is whiter and smaller, and a black ring which is broader and darker when the objective is lowered.

Fig. 144.

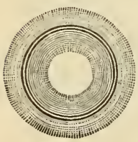
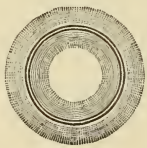


Fig. 145.



Monochromatic Light.—The same phenomena are observed by yellow monochromatic light, except that the diffraction fringes are more distinct, further apart, and in greater numbers than with ordinary light. A fat-globule, indeed, seems to be composed of a series of concentric layers like a grain of starch. With blue light these fringes are also multiplied but are closer together and finer, so that they are not so easily visible. Yellow monochromatic light, therefore, constitutes a good means for determining whether the striæ seen on an object are peculiar to it, or are only diffraction lines. In the former case they are not exaggerated by monochromatic light, but if, on the contrary, they are found to be doubled, or quadrupled, with this light, we may be certain that they are diffraction fringes.

Figs. 144 and 145 show the appearance of air-bubbles in water, when illuminated by yellow and blue monochromatic light.

Atwood, M.—The Microscope in Metallurgy. [*Supra*, p. 735.]
[Sep. Repr. (from Newspapers) of papers read before the San Francisco Microscopical Society.]

Beadle's (J.) Wire Clip for Mounting.
[No description—" it is one of the best and simplest devices we have seen."]
Sci.-Gossip, 1882, p. 207.

BROECK, E. VAN DEN.—Une visite à la Station Zoologique et à l'Aquarium de Naples. (A visit to the Zoological Station and Aquarium of Naples.)

[Brief reference to the excellence of the Microscopical preparations.]

Bull. Sci. Dép. du Nord, V. (1882) pp. 240–54.

Cameo-cutters, Microscopic dexterity of the.

Amer. Natural., XVI. (1882) pp. 762–3, from *Our Home and Science Gossip.*

COHEN, E., and J. GRIMM.—Sammlung von Mikrophotographien zur Veranschaulichung der Mikroskopischen Structur von Mineralien und Gesteine. (Collection of Microphotographs for the demonstration of the Microscopical Structure of Minerals and Rocks.) Parts I.–VI., 48 plates. 4to, Stuttgart, 1881–2.

COLE'S (A. C.) Studies in Microscopical Science.

No. 13 (pp. 109–112).—The Kidney. Plate of Diagrams of the Human Kidney.

No. 14 (pp. 113–18).—Vertical Section of Cluster Cup, *Æcidium compositarum* var. *tussilaginis.* In situ on the leaf of *Tussilago farfara.* Plate × 70.

No. 15 (pp. 119–26).—Horizontal Section of the Human Kidney through Medullary Layer (papillary portion), stained logwood. Plate × 400.

No. 16 (pp. 127–32).—Transverse Section of Aerial Stem of the Field Horse-tail (*Equisetum arvense*), stained carmine. Plate × 100.

No. 17 (pp. 133–40).—The Kidney. Vertical Section Human Kidney, showing part of the Labyrinth and Medullary Ray; injected carmine and stained logwood. Plate × 145.

No. 18 (pp. 141–46).—Transverse Section of Root of Dandelion (*Leontodon Taraxacum*), portion of Xylem, portion of Bast and Cambium, stained logwood. Double plate × 700.

No. 19 (pp. 147–50).—The Lung. Transverse Sections, Bronchus of Sheep in Lung Tissue, stained logwood. Plate × 30.

No. 20 (pp. 151–6).—*Lycopodium Wildenovii.* Transverse Section of Stem, stained logwood. Plate × 300.

No. 21 (pp. 157–60).—The Lung. Vertical Section of Human Lung, stained logwood. Plate × 315.

D., A. R.—Microscopical Cement.

["Patent Knotting" from oil and colour stores, exposed to the air until it has become of the proper consistency,—for mending cells and for preventing running-in of the finishing varnish.]

North. Microscopist, II. (1882) p. 259.

DELOGNE.—Préparation des Mousses et des Hépatiques. (Preparation of Mosses and Hepaticæ.) [*Supra*, p. 706.] *Bull. Soc. Belg. Micr.*, VII. (1882) p. cl.

ELCOCK, C.—How to Prepare Foraminifera. 2nd paper. [*Post.*]

Journ. Post. Micr. Soc., I. (1882) pp. 139–45 (1 fig.).

ERMENGEN, E. VAN.—Préparation des Bactéries de la Tuberculose. Perfectionnements apportés à la méthode de Double Coloration. (Preparation of the Bacteria of Tuberculosis. Improvements in the Method of Double Staining.) [*Supra*, p. 706.] *Bull. Soc. Belg. Micr.*, VII. (1882) pp. cli.–iii.

FLEMING, J. T.—Osmic Acid Mounting.

[Exhibition of *Volvox globator* in osmic acid.]

North. Microscopist, II. (1882) p. 255.

GEORGE, C. F.—Water Collecting-Apparatus. [*Post.*]

Journ. Post. Micr. Soc., I. (1882) pp. 158–60 (1 fig.).

GRAFF, T. S. U.—Resolution of Fasoldt's 18-band plate, and last band of 19-band plate. [*Supra*, p. 416.]

Bausch & Lomb Optical Co.'s Supplement to Catalogue, Feb. 1882, p. 6.

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Note on same by Dr. E. Van Ermengen, in *Bull. Soc. Belg. Micr.*, VII. (1882) p. cliv.–vi.

GRIFFITH, C. H.—Cutting Sections of Coal.

[Reply to F. Kitton, *supra*, p. 587.] *Sci.-Gossip*, 1882, p. 186.

Grimshaw, R.—The Microscope in Engineering Work. [*Supra*, p. 733.]
Journal of the Franklin Institute, CXIV. (1882) pp. 173–5.

Hanaman, C. E.—Filtering Wash-bottle, especially adapted to the use of the Histologist.

[A Woolff's bottle, with tubes arranged as in a chemists' wash-bottle, so that when air is forced into one tube the fluid is forced out of the other. The first tube is provided with a rubber pressure-bulb for compressing the air; the second supports a filtering tube filled with cotton, so that the reagent is always obtained free from suspended particles.]
Amer. Mon. Micr. Journ., III. (1882) p. 169.

Harris, C.—Preserving Natural Colours of Desmids, Algæ, &c.

[Gives receipts for Deane's compound, Ralfs' liquid, glycerine jelly, and solution of acetate of aluminium.]
Engl. Mech., XXXVI. (1882) pp. 21–2.

Harrison, J. S.—The Adulteration of Coffee and the Microscope.

[Contains directions for examining coffee and for distinguishing it from chicory.]
Journ. Post. Micr. Soc., I. (1882) pp. 115–8 (1 pl.).

Hervey's (A. B.) Slides illustrating the Sexual and Asexual Reproduction of the Marine Algæ. *Amer. Natural.*, XVI. (1882) p. 674.

Hitchcock, R.—[Reply to query as to Media for Mounting Plant-hairs, Leaf-glands, and Micro-fungi on Leaves.]
Amer. Mon. Micr. Journ., III. (1882) p. 137.

" " [Report of remarks at Meeting of the New York Microscopical Society on Illumination and Aperture.]
Amer. Mon. Micr. Journ., III. (1882) p. 139.

" " Aquaria for Microscopists.

[Directions for managing small aquaria made of bottles with square sides, holding about 6 oz.]
Amer. Mon. Micr. Journ., III. (1882) pp. 148–50.

Hoyer, H.—Beiträge zur histologische Technik. 1. Karminlösung. 2. Injektionsmassen. 3. Einschlussflüssigkeiten. (Contribution to Histological Technic. 1. Carmine solution. 2. Injection-masses. 3. Mounting fluids.)
Biol. Centralbl., II. (1882) pp. 17–24.

Ingpen, J. E.—Note on "the possible value of an aqueous solution of iodine for preserving and mounting *Volvox* and other Algæ."

[The solution is prepared by adding caustic potash to an alcoholic solution of iodine till it becomes colourless, avoiding any excess of potash. It should be greatly diluted.]
Journ. Quek. Micr. Club, I. (1882) p. 102.

Johnson, G. J.—Mounting Entomostraca.

[In carbolized water. Add a drop or two of water to crystals of carbolic acid to facilitate melting over a gas flame, and pour 5 or 6 minims into half a pint of distilled water. Tissues do not shrink as with glycerine jelly.]
Sci.-Gossip, 1882, p. 206.

Joliet, L.—Sur une nouvelle méthode d'inclusion des préparations propre à faciliter les coupes. (On a new method of imbedding preparations to facilitate sections.)
Arch. Zool. Expér. & Gén., X. (1882) xliii.–v.

Jones, T. R.—The sign ×.

[Reply to Mr. Kitton *infra*, reiterating his views as to the difference between a diagram purporting to represent an object × 500 while it is but an enlargement of one × 50.]
Sci.-Gossip, 1882, p. 206.

Keegan, P. Q.—On the Mounting of Molluscan Palates for the Microscope.

[1. Immerse in rather strong solution of caustic potash for not less than 12 hours. 2. With large camel-hair brush and water vigorously and carefully brush away all trace of muscular or fibrous matter. 3. Wash, transfer to a clean slide, place a piece of linen and a weight over it, and leave some hours to dry. 4. Remove the linen, add a few drops of carbolic acid, drain it away after some minutes, dry carefully and slowly

over a spirit lamp. 5. Apply a few drops of benzole, dry slightly, and mount in balsam and benzole or in dammar in the usual way.]

Sci.-Gossip, 1882, pp. 186–7.

KITTON, F.—The sign ×.

[Objections to T. R. J.'s contention, *ante*, p. 423.]

Sci.-Gossip, 1882, p. 185.

„ Cutting Coal Sections.

[Correction of error in previous remarks, *supra*, p. 587, and that Reinsch's sections of coal are opaque, except the organic remains, which are coloured amber.]

Sci.-Gossip, 1882, p. 185.

„ „ „ [Reply to C. H. Griffiths, *supra*, p. 747.]

Sci.-Gossip, 1882, p. 207.

„ Thin Glass Cells.

[Confirms the editor's view that Dr. Beale has described a similar method of making glass cells to that of C H. Kain, *ante* p. 587 (punching the cell by means of a file from a piece of thin glass placed over a ring), and describes his own modification of the former published in 'Science Gossip' ten or more years ago, and the mode of perforating ordinary glass slides—also note on Chalk Cells, *supra*, p. 718.]

Amer. Mon. Micr. Journ., III. (1882) pp. 151–2.

„ The Preparation of Diatoms.

[Points out that nearly all the methods of R. S. Warren, *ante*, p. 707, are fully described in 'Science Gossip,' 1877, pp. 145 and 217, his plan for eliminating sand being identically the same as given by Mr. Kitton.]

Amer. Mon. Micr. Journ., III. (1882) p. 153.

KORSCHELT, E.—Preservation of Protozoa.

[Abstract of article, *ante*, pp. 437 and 574.]

Amer. Mon. Micr. Journ., III. (1882) pp. 156–7.

LANDSBERG, B.—Preservation of Protozoa.

[Abstract of article, *ante*, pp. 575 and 587.]

Amer. Mon. Micr. Journ., III. (1882) p. 157.

MAYER, P.—See Whitman, C. O.

„ S.—Beitrag z. histologischen Technik. (Contribution to histological Technic.) 14 pp. and 3 pls. 8vo, Wien, 1882.

MIALL'S Microtome (exhibited).

[No description—apparently a simple and economical form, not intended for very thin sections.]

Journ. Quek. Micr. Club, I. (1882) p. 99.

NÖRNER, C.—Beitrag zur Behandlung Mikroskopischer Präparate. (Contribution to the treatment of Microscopical Preparations.) [*Post.*]

Arch. f. Mikr. Anat., XXI. (1882) pp. 351–6.

OLIVIER, L.—Les Procédés Opératoires en Histologie végétale. (Practical Processes in Vegetable Histology.) (In part.) [*Post.*]

Rev. Sci. Nat., I. (1882) pp. 436–54.

PARKER, A. T.—Staining and Preservation of Tube-casts. [*Supra*, p. 705.]

Amer. Mon. Micr. Journ., III. (1882) pp. 153–4.

PARSONS, H. F.—*Daphnia*.

[Describes the (Mr. Bedwell's) plan of adding a few loose fibres of cotton-wool to the drop.]

Journ. Post. Micr. Soc., I. (1882) p. 155.

PERENYI, J.—Ueber eine neue Erhärtungsflüssigkeit. (On a new Hardening Fluid.) *Zool. Anzeig.*, V. (1882) pp. 459–60.

PILLSBURY, J. H.—Cabinet for Slides.

[" Trays with sawed slots for 25 slides in each tray arranged on end in a case with a lid about 2 inches deep to allow the trays to project far enough to be taken out easily when the lid is open. Each case holds 20 trays in two rows, accommodating 500 slides. Labels for the names of the slides are stuck on the upper ends of the trays, and the slides

may be lettered and numbered to correspond with letters on the trays and numbers on the slots if desired. When the lid is open I have a classified list of the 500 slides before me for instant reference."]

Amer. Mon. Micr. Journ., III. (1882) p. 154.

Rogers, W. A.—On Ruling Fine Lines.

[Abstract of paper presented to the Section of Histology and Microscopy at the Montreal Meeting of the A.A.A.S. *Post.*]

Amer. Mon. Micr. Journ., III. (1882) pp. 165–6.

Scott, E. T.—Sections of Coal.

[" Any one with the least knowledge of chemistry can at once say that the plans given for softening coal . . . . could not succeed."]

Sci.-Gossip (1882) pp. 185–6.

Seaman, W. H.—Mounting Plant-hairs and Fungi.

[If rather hard and containing but little water, balsam; but all the more delicate parts of plants and small fungi require a watery medium such as glycerin-jelly prepared to be fluid at common temperatures but stiff at 45° F.].

Amer. Mon. Micr. Journ., III. (1882) p. 178.

Smith's (J. L.) Preparations of Embryo-chicks.

[" Some . . . seem to be absolutely perfect."]

Amer. Mon. Micr. Journ., III. (1882) p. 178.

Stokes, A. W.—Unpressed Mounting for the Microscope. [*Post.*]

Journ. Post. Micr. Soc., I. (1882) pp. 129–35.

Taylor, T.—Improved Freezing Microtome. [*Post.*]

Amer. Mon. Micr. Journ., III. (1882) pp. 168–9 (1 fig.).

Vickers, G. W.—Killing and Preserving Insects.

[Approval of C. M. Vorce's method, *ante*, I. (1881) p. 139, and description of his own mode of procedure. " Place a drop of the acid (pure crystallized with just sufficient water added to keep it fluid) on a slide and drop into it the living insect; it will be seen to struggle for a second or two, then the limbs, wings, and tongue become extended; it then becomes beautifully clear and transparent. The acid should now be drained away, a drop of balsam put on, the cover applied . . . ."]

North. Microscopist, II. (1882) p. 227.

Ward, R. H.—An Adjustable Spring Clip. [*Supra*, p. 725.]

Amer. Natural., XVI. (1882) p. 692 (1 fig.).

" " Cereal Foods under the Microscope.

[Objections to the correctness of Dr. E. Cutter's microscopical analysis of various kinds of flour and meal.]

Amer. Natural,, XVI. (1882) pp. 692–3.

" " The Microscope in the detection of forgery.

[Comment on a lecture (in England) by Mr. John Rogers having been founded on Dr. Ward's Presidential Address, see I. (1881) p. 856.]

Amer. Natural., XVI. (1882) p. 763.

West, T.—An Hour at the Microscope.

[Nine notes on various objects, including two on mounting *Funaria hygrometrica* and *Flustra foliacea.*]

Journ. Post. Micr. Soc., I. (1882) pp. 145–50 (3 pls.).

Whitman, C. O.—Methods of Microscopical Research in the Zoological Station in Naples.

[Transl. of P. Mayer's article, *ante*, III. (1880) p. 551.]

Amer. Natural., XVI. (1882) pp. 697–706.

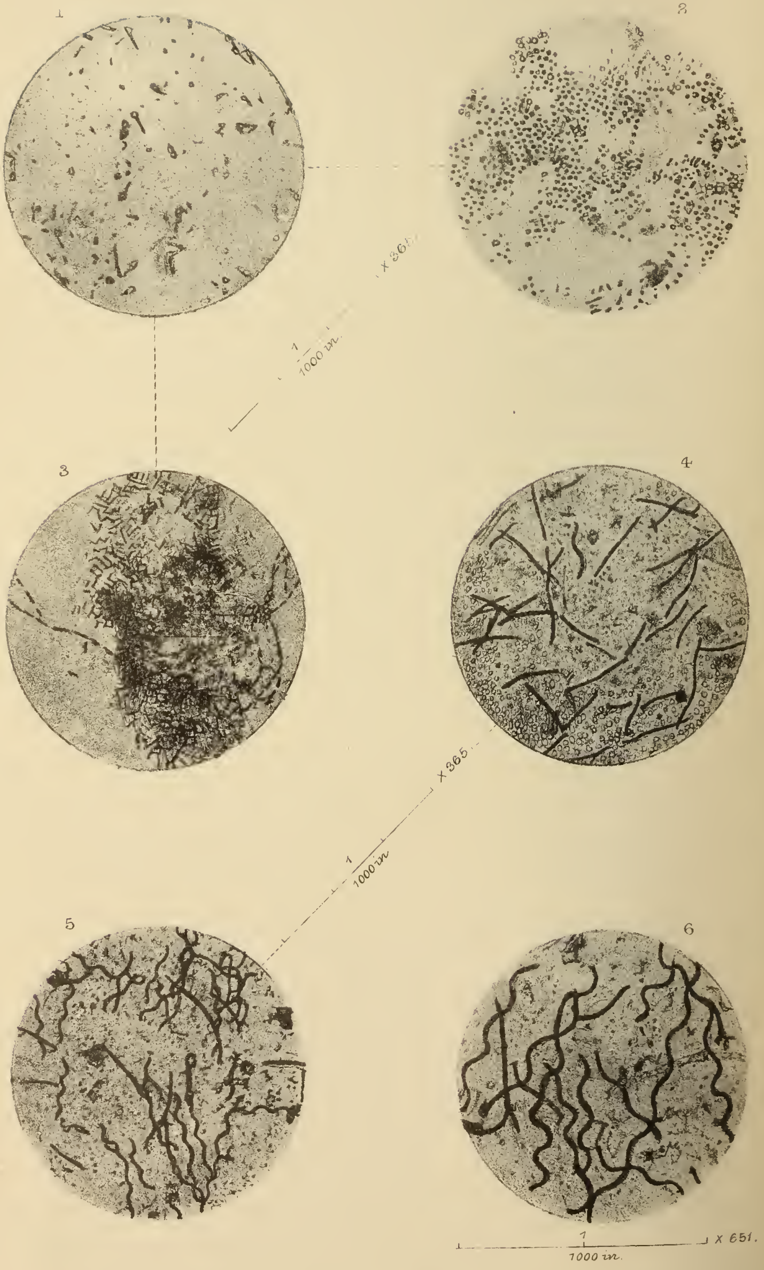


Photo. R. L. M.

West, Newman & Co. lith.

Organisms from excrement of Goat & Goose.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER 1882.

TRANSACTIONS OF THE SOCIETY.

XV.—*On some Organisms found in the Excrement of the Domestic Goat and the Goose.*

By R. L. Maddox, M.D., Hon. F.R.M.S.

(*Read* 8*th November*, 1882.)

Plate VII.

When studying lately the appearances of the hay-bacillus, both in the fresh and putrid infusion of hay, it occurred to me that it would be worth while to examine the excrement of a herbivorous animal, and a grass-feeding bird. Accordingly, I procured the fresh excreta of the goat, and of the goose, taking from the latter only the part but little, if at all, contaminated with urates. The examinations were begun in the month of August last, and as they proved rather interesting, and may open up a study that may furnish results for experiment, I venture briefly to offer a few remarks upon the organisms found. Photomicrographs were made of some of these, by a Seibert's $\frac{1}{16}$ water-immersion objective, without collar adjustment, kindly lent to me by Mr. Curties for this purpose. I may remark that the objective answered well with the

EXPLANATION OF PLATE VII.

(Lithographed from some of the Photomicrographs exhibited.)

Fig. 1.—A few of the free and growing spores found in the mixture of the goose excrement.

„ 2.—Part of the layer immediately beneath the upper layer, containing micrococci, in the mixture of the goose excrement.

„ 3.—Part of the felted mass of short rods, and part of some long free filamentary chains. These appeared later in the same mixture.

„ 4.—The earliest notice of *Spirillum* in the goat excrement.

„ 5.—Shows the marked increase in the number of *Spirilla*, and the diminution in the number of the rods.

„ 6.—*Spirillum* from goat excrement. [The original photomicrograph was taken with the addition of a Zeiss amplifier, and magnified to 651 diameters; the others, each, to 365 diameters.]

camera extended to a certain length, and also when used with a Zeiss amplifier at the same extension; but at distances much beyond, the want of the collar adjustment became rather apparent; hence the enlargement of the objects was chiefly kept within very moderate dimensions, yet sufficient for illustration. I may add, that I believe they are within easy reach of the engraver's power, which apparently was not the case with the photographs of the minute organisms found in rainwater-ice and hail, described in a previous paper.*

The examination was proceeded with in the following manner: a portion of fresh excrement of the goat was broken up with a clean glass rod in some freshly distilled water, and immediately covered with a glass plate. Examined by the Microscope at the time, numerous bacteria of various sizes, and a very few rods of, apparently, hay-bacillus were present, besides large quantities of partially digested vegetable matter suspended in a somewhat glutinous material, most likely mucus from the intestinal canal. The mixture was set aside in the room without artificial heat, the ordinary temperature ranging between 60° and 70° F., and fully exposed to daylight. On the third day when examined there was a thin scum extending over a large part of the surface. This scum contained numerous bacteria, some small rods, and here and there in the thinner parts of the pellicle some bright oval bodies with sharp outlines, whilst free from the scum were many larger and longer rods, both straight, and with a well-marked wide curvature, not angular; these rods were in active movement; there were also a few spores with outgrowths, these had the spore ends nearly globular, and the outgrowth or extension very pale and slightly granular, with a *gentle curve.* These spores had a slight forward and backward movement, also a peculiar swaying motion from side to side, the spore end forming the fulcrum. I believe these must be regarded as the spores of the *Spirillum*, which appeared later. A portion of the upper part of the fluid was removed, and freshly distilled and reboiled water added both to it, and to replace the quantity removed from the original portion. Both vessels, being covered, were placed in a dark box, and kept at a pretty constant temperature of 90° F. for twelve hours, when a fresh examination was made. Both vessels now teemed with infusoria and bacteria, the fluids had become more or less ropy, especially the original one. The organisms in the diluted portion consisted chiefly of active rods of very variable lengths, many having the wide curvature. No spores were visible. The original portion which had been diluted was divided into three layers, the surface one being of a dark greenish-brown colour, the second very much paler, whilst the lowest consisted of the debris of the food.

* *Ante*, p. 419.

The rod organisms in the upper layer resembled those in the diluted portion, but were far more numerous, and in very active movement, the bend in the curved ones being used apparently as an axis for locomotion. The bacteria had very little motion, the fluid being most likely too slimy; no spores were visible at this stage.

Hay was steeped for twelve hours in cold water and the liquid sterilized by boiling; when cold, a portion was added to the original but diluted mixture and gently stirred, whilst another portion of the hay infusion was infected from the former. All three vessels were now left exposed to daylight and the ordinary temperature of the room for a couple of days. Re-examined, the long rods had almost disappeared in the hay infusion that had been infected, and chiefly very short rods could be found; bacteria and infusoria were also present.

In the mixture simply diluted with distilled water, the rods were now fewer and less active; a pellicle on the surface was crowded with motionless bacteria; the infusoria still abounded; there was no offensive smell. The original fluid, or mixture, now diluted with the hay infusion, was examined. It was densely crowded with straight and curved rods of very variable lengths, and a few spirilla were visible, some having only one-and-a-half turns, others two to six; these were in active movement. In Fig. 4 (Pl. VII.) is represented the first notice of *Spirillum* in the mixture. In different parts of the slide some single large micrococci and also smaller double ones were noticed. The infusoria still abounded, and the mixture had now a faint sickly odour. Attention was confined to this mixture. After another twenty-four hours the rods and spirilla appeared nearly equally abundant, some of the latter having as many as thirty-three angular turns. The curvatures, both in width and depth, differed considerably. These organisms continued about matched for four days, when the *Spirillum* got the upper hand, the number of rods lessening; this is fairly well shown in Fig. 5. The survival of the fittest was evidently taking place, but at the same time also appeared another organism contending for the mastery, viz. a very delicate mycelium spreading in every direction through the fluid, which quickly rendered all further observation useless. The fluid was, however, kept for five weeks, and at the end of that period the rods and spirilla had well nigh disappeared, and nothing could be found by which to determine to what object the mycelium belonged. The mycelium was in very long twisted threads not larger than the rods, and at first I fancied they might be the rods in their filament stage, but close examination soon showed this not to be the case, as the threads had short outgrowths at very variable distances.

In the excellent contribution upon the life-history of *Spirillum*

given by P. Geddes and J. Cossar Ewart, M.D., in the Proceedings of the Royal Society, No. 188, 1878, it is shown that at one term of existence, the screw-shaped rods become less twisted, and finally straight, passing into the ordinary rod form as in Fig. 7, given by them. They also suggest that the term *Vibrio* should not be considered as generic. When examining the above-named fluids I have repeatedly found many of the long spirilla motionless, with one half having lost all twist except a large gentle curve, but that end presented a very delicate pale, very finely granular condition, differing entirely from the other part, the end being scarcely visible even when stained, and I have regarded this as a progressive dissolution of the organism. In the case I have mentioned we might have expected the spirilla to have reverted to rods, which was not the case, so far as I could determine, and from the *Spirillum* found in the goat excrement, appearing after and so largely replacing the rods, I think it offers a fair plea that *Bacillus* and *Spirillum* are to be considered distinct, though the latter, when broken up, may greatly resemble bacillus rods. The straight rods I should regard as *Bacillus subtilis*, and the curved ones as merely an accidental variation in their form, though many with a single curvature had very much the appearance of *Vibrio rugula*.

In the same paper it is stated the parent or spore-bearing hyphæ are locomotive, "and the spores quiescent." The authors say, "The life-history of *Spirillum*, so far as we at present know, may be thus summarized. The well-known motile corkscrew may alternate between the active and resting states, and ultimately lengthen out into a small filament, which loses its definite twist, and may freely bend or straighten. This thread grows into a much larger and longer motionless filament in which spores appear. These rapidly divide and acquire a bright brown colour, the filament re-assuming the motile condition, and sooner or later breaking up."

The spiral organisms were rigid, with a spiral movement. In size they appear rather smaller than the figures given of *Spirillum volutans*, and larger than *Spirillum tenue*, approaching nearer to the *Vibrio serpens* of Cohn. If the term vibrio were put aside, would it not be as well to substitute for the curved forms of *Bacillus*, *Bacillus curvatus*, or *Bacillus subtilis* var. *curvatus*, and thus help to get rid of the objectionable term? Having some doubt as to the exact species of *Spirillum*, I have not given more than the generic name.

I found the organisms varied so considerably according as they were left dry upon the cover-glass after or before staining, or mounted in distilled water, or in a semi-saturated solution of acetate of potash, or in dammar medium, that I have not given the measurement. The one method of mounting would not agree with the

others, as shown in some other photomicrographs, taken with the same objective, at the same distance from object to screen; but I have given the measurement of the $\frac{1}{1000}$ of an inch at the same distance.

The examination of the goose excrement, the part not covered with urates, was made by breaking up a portion in freshly distilled water with a clean glass rod, then covering it with a plate of glass, and setting it in the daylight at the ordinary temperature of the room, at the same time as the former experiment. Examined on the slide, chiefly vegetable debris of grass, coarse and fine granular organic and mineral matters, with here and there a bright point, like an ordinary bacillus spore, amongst various bacteria, and a very few short rods were noticed.

After twenty-four hours, a thin scum appeared in several places on the surface of the fluid, which had now settled into three layers, the heavy solid constituents having sunk to the bottom. The top one was of a dense brown colour, the middle much clearer and less coloured. After another twenty-four hours the top liquid was examined; being diluted with a droplet of water on the slide, it was seen to contain numerous very bright oval forms, many with outgrowths of varying lengths, evidently germinating spores, apparently of the hay-bacillus. These had motion forwards or backwards; but not the singular swaying movement from side to side from a fixed point. There were also a few short rods, micrococci, and bacteria present. These were photographed, Fig. 1. On the following day the short rods had notably increased in number, but they did not appear to grow in length; fewer spores in growth were visible. The pellicle on the surface had increased, the part exposed to the air consisting, so far as I could make out, of bacteria mingled with micrococci, whilst immediately beneath, the micrococci formed a layer in a delicate transparent medium. This layer is seen pretty distinctly in Fig. 2. In various parts of the pellicle on the slide, small masses of minute bodies, highly refractive and set in a glœa, larger than the spores of the hay-bacillus, were seen. I believe they belong to a *Bacillus* of larger dimensions, as I have many times noticed similar bodies in connection with a short chain of stout short rods, in other preparations. Continued examinations for many days revealed nothing further; the rods had not grown, and the entire fluid was becoming of a greenish colour throughout, but at last upon several slides the bacilli were seen in chains of some length and in nearly all attached to a felted mass of small rods, and rods lying free, but close to the mass, as depicted in Fig. 3. In the filamentary chain, the joints appeared to be passing into the spore condition in a few. The little mass of free rods were motionless and of rather paler appearance than the ordinary rods of hay-bacillus; the fluid was crowded with infusoria,

there were numerous bacteria, but not active to any extent. The fluid had become ropy, the dark colour had lessened, the odour had become disagreeable. An attempt was made to cultivate the organisms in fresh sterilized hay infusion, but it was unsuccessful.

The original fluid was now stirred up, and allowed to re-settle, still it yielded nothing of change that I could discover upon the examination of many slides. It was kept for more than a month when the fluid had a sour smell and acid reaction. To the latter I think we may attribute the want of growth of the rods generally; evidently the pabulum was not favourable; at this stage a few octahedra of oxalate of lime were seen. The results offered a great contrast to those of the excreta of the goat.

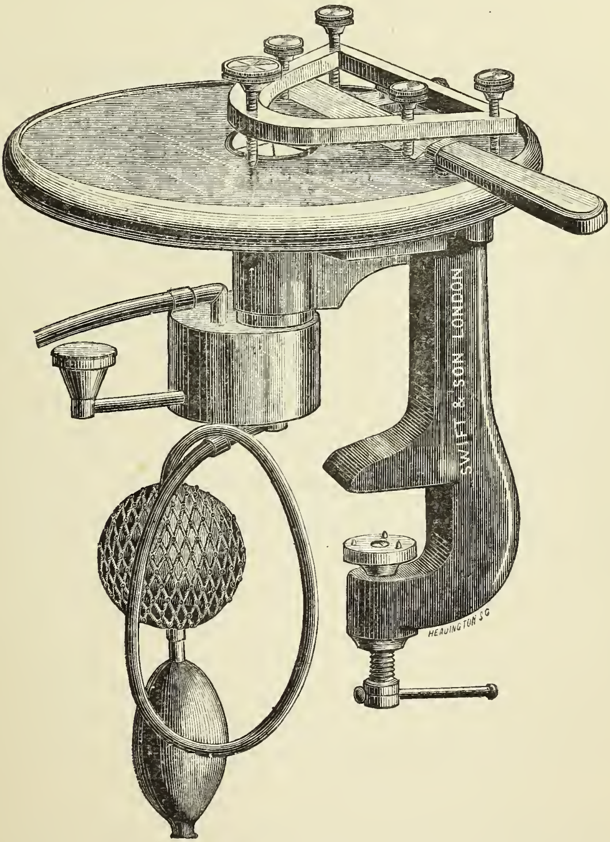
Possibly, by fractional cultivations in proper media, we might be able to arrive at a more perfect study of the different organisms, and test their physiological peculiarities or their pathological reactions, if any. We may, I think, however take for granted that the spores have resisted the entire digestive process in both cases, but whether they, or the spirilla, would prove detrimental to guinea pigs or mice, I must leave to the care of those armed with the necessary powers, in this country, for such studies.

XVI.—*A Further Improvement in the Groves-Williams Ether Freezing Microtome.* By J. W. Groves, F.R.M.S.

(*Read 8th November*, 1882.)

In the present volume of the Society's Journal, page 430, Fig. 83, is described and figured the method by which, at my suggestion, ether was adopted as the freezing agent to a Williams microtome,* the chief merit being that the used ether is capable of being conveyed away into the external air without the operator being exposed

Fig. 146.



to its fumes, as is the case in most ether freezing microtomes, while at the same time the advantages of the Williams instrument are retained.

* Cf. this Journal, i. (1881) pp. 697–9 (1 fig.).

On page 432, Fig. 84, is shown a so-called improvement, though one which is useless, inasmuch as the razor is incapable of being levelled, and therefore cannot be kept parallel with the slides on which it works, the result being that no sections with parallel surfaces, and therefore no *thin* sections, can be cut.

The present further modification, Fig. 146, has consequently been made by Mr. Swift, of Tottenham Court Road, at my request. The machine now resembles that last mentioned in having an iron bracket with spring tube to receive either of the four holders for material, Figs. 84–7, and a clamp below by which it may be fixed to a table; but differs from it in that it has the glass top and razor-frame of the original Williams microtome.

The new Microtome, therefore, consists of an iron bracket to the top of which is fixed a glass plate with central aperture. Through this passes the upper end of the apparatus for holding the material to be cut, either for freezing by ether as in Figs. 146 and 84, or by ice and salt, as in that known as Pritchard's, Fig. 85, or for material imbedded, Fig. 86, or for clamping a tree stem or other structure not requiring to be frozen or imbedded. Each of these is held below the top in a spring tube capable of being tightened by a screw, and the whole instrument can be fixed to a table by a clamp which forms the bottom of the bracket. The sections are cut by a razor held in a Williams triangular frame, which is levelled by means of two base screws, and lowered for each section by means of the apex screw.

When using the ether freezing apparatus with this microtome, material to the thickness of $\frac{3}{16}$ inch can be frozen in $1\frac{1}{2}$ minutes, and good successive sections cut as thin as can be obtained by any microtome. When the material is once frozen scarcely any ether is required to keep up the action, so that the cost of the ether is rather less than that of ice, methylated ether sp. gr. ·720 at 1*s*. 6*d*. a lb. being used.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Spermatogenesis in Mammalia.†—G. Renson finds that, when the testicular canaliculi of the rat are treated with osmic acid, the following sets of cells may be made out: (1) Large, rounded cells with large nuclei, the protoplasm containing a number of granulations —these are the seminiferous cells of Sertoli. (2) Multinuclear cysts provided with a variable (4-20) number of nuclei, and varying in form according to their stage of development. Frequently the nuclei are slightly elliptical, an appearance which appears to be the forerunner of their conversion into the heads of the spermatozoa; in such cysts there is a distinct differentiation of the protoplasm, which has become condensed and limited around each nucleus; so that, when completely developed, we have rather to do with aggregations of cells than with multinuclear protoplasmic masses. (3) There are also small rounded cells, the nucleus of which presents every stage in the development of the head of the spermatozoa; these, which, with Sertoli, the author calls nematoblasts, have, like their predecessors, a refractive corpuscle placed near the nucleus.

The whole series of changes may be thus expressed: a generation of spermatozoa is developed, and expelled into the lumen of the canaliculus; the seminiferous cells multiply to form a new generation of nematoblasts; germ-cells are developed from a peripheral protoplasmic plexus which takes on the characters and situation of the seminiferous cells; a new generation of germ-cells is developed in the outer portion of the canaliculus. The author has not been able to determine the origin of these germ-cells. The result of following

* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Arch. de Biol., iii. (1882) pp. 291-334 (2 pls.).

out the history of these bodies is to show that there is a regular replacement of one generation of cells by another, and, owing to this, a second may take the place of the one expelled.

Early Changes of the Chick.*—It is certainly to be desired, in the nterests of embryological students, that the principal facts and inferences relating to the chick's development could at length be established beyond the reach of controversy. For, alike on historical, practical, and scientific grounds, this accessible type seems likely to maintain its place as the standard of comparison for the embryogeny of the higher vertebrates, and especially for the study of their initial phases. The rapidity, however, with which these phases succeed one another, and the diverse changes which, within very short periods, occur in different parts of the same organism, present difficulties of observation so great that our most skilled experts have not yet been able wholly to overcome them. Hence our best works, those of Kölliker and Balfour, cannot be regarded as in all respects satisfactory. Hoping to dispel some remaining doubts Dr. W. Wolff returns to this familiar subject; his observations suggest a discussion and review of certain opinions of his predecessors.

As regards cleavage there is not much to be said. Why, he asks, should writers assert that it occurs more rapidly near the centre and surface than in the deeper and outer parts of the germ? No one has proved this. A uniform rate for the change in question being assumed, it must be over sooner in the region where it began. The formation of the subgerminal cavity is best explained if we compare it to the cleavage-cavity of mammals. Since the yolk retracts before it divides, secreting at the same time a fluid mass, so, with the approximation of the cleavage-spheres, becoming successively smaller firmer and more numerous, their intercellular fluid likewise accumulates and in the chick is lodged within the cavity formed by the withdrawal of the entire germ from the food-yolk below. No membrane separates the nutrient yolk from the germ. The false appearance of a membrane on the floor of the germinal cavity is produced artificially by coagulation of a film of the fluid white yolk.

The margin of the hitherto lenticular germ becomes, in the lower portion of the oviduct, thicker than its centre, the central cells probably spreading themselves as the primitive outer lamina is developed. This "ectoblastoderma" is polyderic. Its cells are more easily stained than those of the rest of the germ. The under surface of the outer layer, in contact with this residuum, is uneven; but whether, once formed, it receives cells therefrom or has henceforth an altogether independent increase is not certain. There are now, in the still unincubated germ, two kinds of cells and two only, (*a*) those of the ectoderm, distinguished by their position, form, and chemical characters, and (*b*) the cells beneath them, which do not constitute a lamina and are best termed collectively the "remnant of the cleavage-elements." These residual cells, compacted peripherally, are but loosely grouped about the middle of the germ, which, partly on this

* Arch. f. Mikr. Anat., xxi. (1882) pp. 45–64 (1 pl.).

account, partly in consequence of the development of the ectoderm, appears thinner than it really is. Some of them lie scattered in the germinal cavity; others rest on its floor.

The first consequence of incubation, apart from the increase of all the cells of the germ, is the transformation and union of its deepest residual cells to constitute the monoderic inner lamina or "endoblastoderma." This layer consists of cells no longer rounded but like those of an epithelium and flattened, save where they are rendered thick by their large nucleus, so that in sections they seem fusiform. The under surface of the whole germ is protected by the inner lamina, which therefore roofs in the germinal cavity and beyond the latter is in close contact with the white yolk. Whether this outer portion be first formed or the transformation of residual into endodermic cells proceed contrary-wise, from centre to circumference, has not been determined.

In a bird's-eye view of the germ at this stage are seen an area pellucida and an area opaca. The former is conterminous with the germinal cavity. The latter corresponds to the peripheric region of the germ, resting on the surface of the white yolk. Such a germ differs from a typical gastrula in that between its outer and inner laminæ are included cells not derived from either. These are the cells of the "middle-germ," or mesoblast.

Soon after the inner lamina can be distinguished, a dark spot shows itself, somewhat excentrically, in the clear area. This is the embryonal shield of von Baer. It is mainly due to a thickening of the outer lamina, and its appearance marks the development of the primitive streak, whose broadened cephalic border it represents. The primitive streak owes its origin to an invagination of a part of the outer lamina. The part so invaginated is cut off. But it soon ceases to form one whole clearly separable from the cells of the middle-germ, wherein it becomes implanted. For here cells are associated which have a twofold origin, ectodermic and mesoblastic. Hence many of the contradictions into which discordant observers have fallen. [It is a pity that time did not permit Dr. Wolff to study the remarkable conclusions of the late Prof. Balfour on this subject.*] The floor of the primitive streak, thus reinforced by a copious contribution of cells from the middle-germ, Dr. Wolff terms the "axial plate." As the germ continues to grow, the axial plate gives rise to the rudiment of the cerebro-spinal system, the primitive vertebræ with the lateral plates, and the chorda. The primitive groove and its boundaries are designated, in consequence, dorsal. Our author does not consider the medullary and primitive grooves as distinct formations, and denies the possibility of a displacement of one in front of the other. The peripheral portion of the axial plate extends into the opaque area. To this portion, chiefly, if not exclusively, derived from cells of the middle-germ, the phase "vascular lamina" may conveniently be applied.

The accumulation of cells from the middle-germ about the ectodermic rudiment of the primitive streak is contemporaneous with

* See Quart. Journ. Micr. Sci., xxii. (1882), p. 174, and this Journal, *ante*, p. 314.

(and results from) the disappearance of the peculiar marginal thickenings which the blastoderm, since losing its lenticular figure, has hitherto presented. While the mesoblast coincided in extent with the ectoderm, it most abounded in the hinder and outer regions of the germ, being more sparingly manifest anteriorly and in the area pellucida. But with the formation of the primitive streak a rapid centripetal migration of the middle-germ ensues, and its cells retreat within the limits of the clear area. Much confusion prevails as to the use of the phrases—marginal protuberance, germinal wall and germinal protuberance. The "Keimwall" of His belongs to the white yolk. It is identical with the "Keimwulst" of Kölliker, which, however, the latter views as synonymous with the "Randwulst" of Goette. But this lies wholly outside the white yolk, and is made up of the residual cells between it and the outer lamina.

Remak first instituted the conception of germinal laminæ as at present understood. [To a certain extent he was anticipated by C. F. Wolff and von Baer.] He was tolerably right as to his facts, but erred in his deductions. Unacquainted with the cleavage of the hen's egg, he could not well appreciate its constitution before the formation of the ectoderm, nor could he perceive the significance of the germinal layers in the development of the higher animals generally. He describes the germ of the unincubated egg as made up of a firm outer and a more loosely constructed inner lamina. From the latter, as a first result of incubation, his alimentary glandular lamina separates by transformation of its cells. The residue of the inner lamina is now the middle lamina. Apart from this derivation, at least nominally, of one germinal lamina from another, he finally has at his disposal a middle and an outer lamina but not an inner; since his first inner lamina is resolved into the middle and the alimentary glandular lamina, which latter alone he deems the earliest rudiment of a definite system of organs. Remak's interpretation had many followers. They differ from him in words only who derive a middle lamina from his inner lamina and give this name to Remak's "Darmdrüsenblatt." It is all the same whether *a* splits from *b*, or *b* from *a*.

This "Darmdrüsenblatt" is the inner lamina of Kölliker. What remains of the germ constitutes the outer layer, in Kölliker's sense. From it, therefore, he derives his middle lamina, which is formed by the extension of masses of cells from the region of the primitive streak, on both sides of the germ, between its ectoderm and endoderm.

Goette is right in describing a previous transfer of cells from the marginal protuberance, centripetally. But this wandering does not take place until after the formation of the inner layer. The migrating elements are cells of the middle-germ, and together with the cells of the primitive streak they make up the axial plate. The inner germinal stratum of Goette, which divides into his inner and middle laminæ, is equivalent to the first inner lamina of Remak, who sometimes also designates this as the inner "Keimschicht."

Peremeschko, like Kölliker, is wrong in believing that in the formation of the ectoderm and endoderm the whole substance of the

germ is used up. He derives his mesoderm from large spherical elements, described by him as cleavage-spheres, which wander from the floor of the germinal cavity into the space between the primitive layers. These elements, the megaspheres of His, are when first evident merely the residual cells of the germ; at a later stage they are aggregates of cells whose nuclei and borders have become inconspicuous through inception of yolk-granules. They are endowed with an extraordinary power of multiplication. The inner lamina, once formed, shuts off the rest of the germ from the germinal cavity, and by this time has received into itself the spheres in question, now for the most part resolved into their constituents, whose upward movement from the floor of the germinal cavity is due to their being specifically lighter than its contained fluid.

His resolves the germ of the new laid egg into one lamina, the outer, designating the residual cells collectively by the not well chosen name of subgerminal processes. After the formation of the inner lamina there appears in connection with the primitive streak what he justly enough terms the intermediate stratum. His does not derive all the connective tissues from this stratum, but imagines a migration of cells from the white yolk, out of which the vascular system is developed.

Until the appearance of the primitive streak the germ grows uniformly throughout. At its margin the outer and inner laminæ make together an acute angle, between the legs of which, as seen in sections, cells of the middle germ are packed. As soon as the primitive streak is formed, these cells back towards it and become involved in the constitution of the axial plate. Thereupon the margin, deprived of its intermediate cells, appears as a solid keel, with three or four tiers of cells only, exclusively made up of the ectoderm and endoderm. While this peripheral region continues to spread itself, the under cells separate from the upper, of which only a single tier now remains in continuity with the outer lamina. Some of the separated cells at once assume the features of the cells of the inner lamina (roofing the germinal cavity), as a prolongation of which they extend, beneath the outer layer, under the form of a thin membrane. This limiting membrane rests on the white yolk, but does not attain the extreme periphery of the germ. It there passes into an irregular mass composed of the other separated cells, which wander into the white yolk, become stellately branched, and anastomose to form a network whose meshes get filled with white yolk-spheres. Close to the margin of the germinal cavity, disappearance of the yolk-spheres changes this reticulum into a solid (polyderic) layer, passing gradually into the monoderic inner lamina. It can scarcely be doubted that all the cells between the outer lamina and the white yolk must be considered as representing the endoderm peripherally. The reception of granules from the white yolk may be termed a sort of primitive digestion. Subsequently, when the vascular lamina grows into the area opaca, it is separated from the white yolk by the limiting (endodermic) membrane, and its first formed vessels take up the nutrient fluid which through this membrane they receive. Cells,

however, are not thus transferred. The cellular elements detected by Goette on the floor of the germinal cavity, and thence seen to wander, at an early period, into the germinal wall, must not be referred to the white yolk itself. Certainly the latter contains cells, but these, as above shown, have come from the cleaved germ, to which they return. The white yolk has no direct share in the formation of the embryo.

It is well to be prepared with a definite answer to the question—what is a germinal layer? The cells constituting a primitive lamina must fulfil two conditions;—they must arise directly from the germ, and possess their own peculiar properties. But two such laminæ can be demonstrated, the ectoderm and the endoderm. We should not reckon as primitive layers either (*a*) the aggregate of residual cells (inner pro-embryonic layer of Goette = first inner lamina of Remak) which lies beneath the ectoderm of the egg before incubation or (*b*) the mesoblast, which consists, when first formed, merely of undifferentiated cells of the germ, after its ectoderm and endoderm have separated. The admission of the middle-germ to the rank of a fundamental embryonic lamina renders impossible all attempts to settle the homologies of the primitive layers among the different classes of animals. But if we accept two primary layers only, this difficulty is removed at a stroke.

Thus, in like manner, may we classify the tissues from an embryonic point of view. They are either simple or compound. The simple tissues are ectodermic, endodermic or mesoblastic. The compound tissues are formed by the union of cells from the middle germ, or their derivates, with cells from the ectoderm or endoderm. This union is closer and takes place at an earlier stage of differentiation in the case of the striped muscle of vertebrate animals than with their cerebro-spinal system. We know that in some cœlenterates at least the muscular and nervous tissues are purely products of the ectoderm. There is still doubt as to the origin of many of the so-called endothelia.

Dimensions of Histological Elements.*—W. Krause gives a list (in 26 pp.) of the dimensions of the various histological elements, classified under different headings, such as Connective Tissue, Muscular System, Nervous System, &c.

"Nervous System" (e. g.) is subdivided into Nerve Tissue, Spinal Cord, Brain, Peripheral Nerve System, and Nerve Endings, and the 1st subdivision is dealt with thus:—

Nerve fibres, 0·0018–0·013 (Krause), 0·001-0·02 (Kölliker) thick.

Olfactory fibres, 0·0038–0·0068 wide, 0·0018 thick. Nuclei, 0·0068–0·0113 long (Frey).

Pale nerve-fibres, 0·0017–0·0027 thick (Krause); (in Mammals) 0·0033–0·0056 wide, 0·0013 thick; Nuclei, 0·006–0·015 long, 0·0045–0·0067 wide (Kölliker).

Medullated nerve-fibres and *ganglion-cells* are dealt out in a similar way.

* Krause, W., 'Nachträge zum ersten Bande des Handbuches der Menschlichen Anatomie von C. F. T. Krause (3rd Aufl.).' 8vo, Hannover, 1881, pp. viii. and 170 (1 pl. and 81 figs.).

Influence of the External Medium on the Saline Constituents of the Blood of Aquatic Animals.*—L. Frédéricq points out that the water of the North Sea contains a little more than 3 per cent. of soluble salts, and has a marked salt and bitter taste; the blood of the Crustacea and Cephalopoda living in it has exactly the same taste, which leads to the supposition that it has the same chemical constitution; and this view is supported by chemical analyses. The blood of the crabs of the brackish water of Braeckman has a less salt taste, and that of the crayfishes of the Belgian rivers still less so. It would, then, seem to be certain that, in virtue of the laws of diffusion, there is a more or less perfect exchange of salts between the blood and the external medium, and the seat of this process is probably the gills. But this variation in chemical composition, according to the characters of the external medium, would appear to be confined to the "lower animals"; a similar diffusion might take place in fishes, but in them we find that the saline constituents of the blood are very different to those of the seas in which they live; an explanation of which may be found in the fact that the blood is in them much more isolated from the surrounding medium than it is in the invertebrate marine forms.

B. INVERTEBRATA.

Development of some Metazoa.†—In the third part of his studies on Comparative Embryology, E. Metschnikoff states that he finds that the identity between so called *Archigastrulæ* does not exist as Haeckel has supposed; nor must an *Archigastrula* be always bilaminate, for some very primitive forms contain mesodermal cells even during the blastula stage. Indications of a radial structure of the archigastrulæ have not been detected in the Echinodermata only; doubly symmetrical arrangements are not at first seen in the blastopore, and the elongated form of that structure must not, when found, be regarded as of palingenetic, but of adaptive origin. On the supposition that the radial gastrula form is the primary one, the question arises whether the gastrulæ of Echinoderms, and of such forms as *Lineus* and *Polygordius*, are really homologous; if they are so it would seem to be a necessary consequence that the anus of the Echinopædia is the homologue of the pharyngeal orifice of the worm—a comparison with which the author is apparently dissatisfied.

It is a question whether the Gastræa theory affords the promised key to the solution of morphological problems; the author points out that the formation of the endoderm, in many of the lowest Metazoa, by the appearance of separate cells in the segmentation cavity, can by no possibility be regarded as a compression of the process of invagination, though, on the other hand, the invagination seen in the higher Cœlenterata may quite easily be regarded as a shortened process. If we want to remain true to the Gastræa theory, we must suppose not

* Bull. R. Acad. Sci. Belg., iv. (1882) pp. 209–12.
† Zeitschr. f. wiss. Zool., xxxvii. (1882) pp. 286–313.

only that the head of the worm corresponds to the hinder end of the Echinoderm-larva, but that the mode of formation of the endoderm in the lower Metazoa has no phylogenetic significance. The so-called *Acœla* will have to be regarded as degenerate forms, though they are neither parasitic nor sessile. All these difficulties may, however, be overcome by the supposition that the *Gastræa* does not represent the most primitive form of Metazoa, but a later stage which succeeded upon that of Metazoa without a digestive lumen, and with an internal digestive parenchyma. From this point of view the parenchymatous larvæ of sponges and hydroids, as well as the lowest acœlous Turbellaria, must be regarded as being closely allied to one another, and as representing the oldest Metazoa. It was not till later that there were developed from them animals with a differentiated enteric canal, like the hydroid polyps of the present day, where we see repeated the most important phylogenetic phases (migration of endodermal cells, formation of a solid parenchyma, and later development of an enteric lumen). The earlier development, in the course of time, of the endoderm may be compared to the early formation of such organs as the vertebrate notochord, and the change in time may well be allowed to have exercised a not unimportant influence in the process of gastrulation, and the large blastopores of some forms may be best ascribed to adaptive modification; to this also would appear to be due the appearance of several gastrula stages in the development of one and the same animal form.

In conclusion it is pointed out that, while in some cases we have this hypergastrulation, in others there are formed pseudogastrulæ, that is, stages similar, but not exactly corresponding to gastrulæ. Here may, perhaps, be ranged E. van Beneden's rabbit-gastrula, or his *Dicyema*, while an interesting example is to be found in the Cyclostomatous Polyzoa, the gastrulæ of Barrois being in fact preceded by a much earlier stage in which the endoderm is really formed. The author's notes on *Discoporella radiata* bring to an end a most suggestive essay.

Symbiosis of Dissimilar Organisms.*—G. Klebs here discusses symbiosis with mutual adaptation, which is generally represented by forms which are very widely separated, and often belong the one to the animal and the other to the vegetable kingdom. Instances are cited both among plants and animals; among the latter the corals are perhaps as remarkable as any, and here we frequently find that while the guest is dependent on the coral, the latter does not seem to require the guest; when, however, it is present, it may lead to very considerable modifications in the form of its partner. The specific characters of *Heteropsammia michelini* are to be referred directly to the presence of an *Aspidosiphon*.

Another set of relations is well shown by the case of the crab *Pagurus prideauxii* and the Actinian *Adamsia palliata;* when the former changes its shell, it seizes on the anemone by its chelæ and carries it off to its new home. The latter is completely adapted to

* Biol. Centralbl., ii. (1882) pp. 385–99.

its mode of life, for it has two pedal lobes which become firmly attached around the orifice of the shell. The Actinian would appear to seize and strike smaller marine animals by its stinging cells, and these would thus come into the area of the sedentary crustacean. Like other writers on this subject at the present time, the author directs his notice to the yellow cells found in the Radiolaria.

Pelagic Fauna of Fresh-water Lakes.*—Professor F. A. Forel considers that Entomostraca alone show the peculiar character of pelagic animals, the pelagic fauna in its general features being similar in all the countries and lakes of Europe yet investigated, though seldom represented in any one lake by all the animals of the fauna.

The characters common to the animals of the pelagic region are due to their mode of life. They must swim incessantly, and therefore, instead of any organ of adhesion, they have a highly developed natatory apparatus; they are sluggish, and escape their enemies by their nearly perfect transparency, which may be regarded as a mimicry acquired by natural selection, only those having held their own which are as transparent as the medium in which they live. They perform daily migrations, during the night swimming at the surface, and in the day descending into the depths.

As to the origin of the pelagic fauna, the author decides that certainly the palustrine or fluviatile Entomostraca have not become transformed in each lake into pelagic species or varieties. The almost complete identity of the European pelagic Entomostraca shows a common origin and distribution, and he believes that we must find the cause of the differentiation of the pelagic fauna in the combination of two different phenomena—the daily migrations of the Entomostraca, and the regular local winds of the great lakes. On the borders of great masses of water two winds prevail, one blows at night from the land to the water, the other by day from the water to the land. The nocturnal animals of the shore-region which swim at night at the surface are at this time driven towards the middle of the lake by the surface-current of the land wind, sink during the day (being driven away by the light into the deep water) and thus escape the surface-current of the lake-wind, which would otherwise have carried them again to the shore. Constantly driven further every night, they remain confined to the pelagic region, as they are not carried back again during the day. Thus a differentiation takes place by natural selection, until at last, after a certain number of generations, there remain only the wonderfully transparent and almost exclusively swimming animals which we know. When this differentiation has once taken place, the pelagic species is conveyed by the migratory water-birds from one country to another, and from one lake into another, where it reproduces its kind if the conditions of the existence of the medium are favourable. In this way we may find the pelagic Entomostraca in lakes which are too small to possess the alternation of winds, the animals having been differentiated by the action of the winds in other larger lakes.

* Biol. Centralbl., ii. (1882) pp. 299-305. Ann. and Mag. Nat. Hist., x. (1882) pp. 320-5.

In this way we can easily explain the differentiation of most pelagic species, with the exception of *Leptodora hyalina* and *Bythotrephes longimanus*, which are not related to the other fresh-water species, and for which we must, therefore, seek a *marine* origin. *Bythotrephes* would be derived from an ancestor which was common to it and to *Podon*, its nearest ally. *Leptodora*, on the contrary, according to Weismann's view, would have branched off from a primæval Daphnid, of whose direct descendants nothing further is known.

But how could the passage from salt to fresh water be effected? Pavesi supposes the closing of a fjord, and its gradual conversion into a fresh-water lake. This is possible; but for the definite decision of the question we have still no reliable materials. So soon, however, as the adaptation to fresh water had been effected, the distribution of these forms of marine origin took place in the same way as with other pelagic fresh-water forms, and thus these two forms would be introduced into lakes which were never in direct communication with the sea.

Professor H. N. Moseley also delivered an address * on "Pelagic Life" (Fauna and Flora), at the Southampton Meeting of the British Association, which constitutes a highly interesting summary of our existing knowledge on the subject.

Mollusca.

Curious Secretion in Gasteropods.—The parts termed salivary glands in prosobranchiate gasteropods are far from being sufficiently understood; they offer a tempting subject of research to young investigators. In particular is this the case with *Dolium galea*, the largest gasteropod of the Mediterranean. Poli was the first to notice the œsophageal organs of this mollusc. Keferstein has given an original description and figure of the whole apparatus in Bronn's 'Thier-reich.' Troschel noted the very acid "saliva" of *Dolium*, in which Boedecker found by analysis a large percentage of SO_4H_2. De Luca and Panceri confirmed his results, obtaining more than 3 per cent. of free sulphuric acid. They also observed that much carbonic acid was given off when the freshly excised "glands" were placed in contact with the air, and further showed that other prosobranchs, as well as *Aplysia*, likewise yielded free sulphuric acid. They especially indicated the enormous size of the "glands"; in a *Dolium* whose total weight was 1305 grammes, the shell weighed 550 and the "glands" 150 grammes. Hoppe-Seyler remarks that a secretion so wonderfully composed as that of *Dolium* has nothing in common with the saliva of the higher animals. Another eminent physiological chemist, Dr. R. Maly,† has lately studied this "saliva" and expresses similar doubts. He finds that, added to alkaline neutral or acid solutions, together with albumen fibrin or starch, it digests none of these substances. Neither could he detect any ferment in the

* 'Nature,' xxvi. (1882) pp. 559–64.

† SB. K.K. Akad. Wiss. (Wien), lxxxi. (1880) p. 376, and Monatsb. f. Chem., i. pp. 205–15.

"glands" themselves. He concludes that this acid fluid is of no use to the animal when once secreted, and he again directs attention to the peculiar structure of the so-called glandular organs, which much need a thorough re-examination.

Olfactory Organ of Parmacella.*—H. Simroth, dealing with the olfactory organ of this terrestrial pulmonate gasteropod, and with the question whether there is any relation between the olfactory sense and respiration, points out that the pulmonary tissue is extremely well developed, and that from the anterior edge of the respiratory space there extends into the mantle-cavity a shallow groove, bounded by two distinct ridges; these are in length at least equal to that of the transverse diameter of the body, they are richly provided with ganglion-cells, and traversed by bundles of muscular fibres. There can, then, be no doubt that we have here a sensory organ, and that that organ is olfactory in function.

Another question which arises is as to the homology of this part with the olfactory organ of aquatic gasteropods. The position and mode of innervation of the organ makes this very doubtful, and, taken in conjunction with the systematic position and life-history of the possessor, leads us to think that we have here to do with a recently acquired structure.

Innervation of the Mantle of Lamellibranchs.†—L. Vialleton has studied *Unio* and *Anodonta* by removing the mantle from its attachments in a living specimen, and placing it for 15 minutes in lemon juice, and then for about 20 in a 1 per cent. solution of chloride of gold. Feebly acidulated water is added, and, after 24–36 hours' maceration, the examination may be entered upon. In the portion of the mantle situated within the pallial impression, the nerves are found to be especially distributed along its two faces, a little below the epithelium; from their mode of union there result nodal points of varying form, and a plexus presenting spaces differing in shape and size; from each superficial plexus there are given off finer fibres, which either arise directly from larger nerves or from the finer branches of them; they finally divide into ultimate fibrils which form a closely-set subepithelial plexus. The whole arrangement may be compared to that which is found in the connective tissue of the cornea of the human eye. Observations on allied forms lead the author to believe that this arrangement is common to all Lamellibranchs.

Differentiation of Protoplasm in Nerve-fibres of Unionidæ.‡—In investigating this subject, J. Chatin, after treating with osmic acid, teases the nerve-fibres of *Unio pictorum*, *Anodonta cygnea*, &c., stains with carmine or anilin red, and mounts in glycerine. The axis of the fibre consists of a bundle of fibrils longitudinally arranged; around this bundle lies a protoplasmic layer containing nuclei here and there, but difficult to observe. The protoplasm is finely granular;

* Zool. Anzeig., v. (1882) pp. 473–5.
† Comptes Rendus, xciv. (1882) pp. 461–3.
‡ Ibid., pp. 1723–6.

it contains spheroidal refringent myeloid globules, coloured black by osmic acid; they multiply rapidly, but remain distinct and are comparable to the myelin of Vertebrata. Pigment-granules of a brownish or yellowish colour, found in some ganglia, are often seen in the protoplasm of the nerves; they are not altered by ether or chloroform. Transverse sections of the nerves show this protoplasmic layer to constitute the entire covering of the central fibrils, and to be approximately homogeneous in density throughout; although a slightly denser external zone is somewhat constant in its occurrence, it is not dense enough to be comparable to the Schwann's sheath of the Vertebrate nerve.

Molluscoida.

Disdaplia.*—A. Della Valle, in describing this new genus of the Synascidiæ, states that the tail of the larva presents the following constitution: there is an envelope of cellulose, with amœboid nuclei, a membrane continuous with the ectoderm, which is formed of large, flattened epithelial cells, a contractile layer of fusiform cells which are transversely striated, and the axis of the tail, which is more transparent than the rest, and is occupied by the hyaline cylinder, which is, according to some, a solid cartilaginous notochord; the author, however, like some other writers, finds that this axial structure is a hollow tube, the wall of which is continuous with that of the peritoneal sac.

Attention is to be directed to the fact that the first buds which are developed in a young colony have no sexual glands, but those that are derived from the later colonies (due themselves to the repeated fission of the primitive buds) present at once indications of these glands, or at least of groups of cells which will develope into them. The author promises to prove in a later work that this phenomenon is not peculiar to *Disdaplia*, but is to be seen in other Synascidians.

Natural History of Doliolum.†—B. Uljanin concludes that, in the developmental cycle of *Doliolum*, only two generations succeed one another; one of them is developed from the egg, is provided with a *stolo prolifer*, and gives rise to a generation of nurses; the other is derived asexually from the stolon, and this latter generation is polymorphous; the separate forms which constitute it have hitherto been regarded as special generations, and distinguished as lateral buds, median buds (second generation of nurses), and sexual forms; of these, the two former have rudiments of reproductive organs, which disappear during the course of development. *Doliolum* may be looked upon as a form which has inherited a process of alternation of generations from the *Synascidiæ* and *Pyrosomidæ*, and in which, owing to a slow diminution in the amount of nourishment, the nurse developed from the ovum has gradually been subjected to a series of adaptation, for the purpose of the preservation of the species. The want of true colonial life has diminished the amount of gemmation

* Arch. Ital. de Biol., i. (1882) pp. 193–203.
† Zool. Anzeig., v. (1882) pp. 429–36, 447–53.

and the thickness of the protecting mantle, which is here merely a feebly developed hyaline layer, derived from the ectoderm and without any special cells.

Development of Ganglion and Ciliated Sac in Pyrosoma.*—The ciliated sac, or "olfactory organ," has been studied by L. Joliet in the bud of this Tunicate. The walls of its canal consist of a cubical non-ciliated epithelium, a few cilia and flagella occurring, however, at the point at which it opens into the branchial sac; the median tubercle is composed of a mass of small round cells, grouped round a diverticulum of the canal. The organ evidently represents the canal of the gland of the Ascidians proper, the anterior ciliated part corresponding to the "pavillon," and the median tubercle being apparently a rudimentary gland. Kowalewsky is wrong in speaking of a cavity within the ganglion, and of the obliteration of the cavity of the primitive neural canal, for he has mistaken the latter for the ganglion. The canal is constricted at each point at which a young bud is given off, and thus forms a pear-shaped vesicle within each older zooid, and its walls undergo modifications. From its hinder end, which thickens, some round cells between the vesicle and the ectoderm are detached; these cells proliferate actively, and form an oval mass which grows round the posterior end of the vesicle, constituting the true ganglion in almost its adult form. The vesicle opens into a depression in the branchial sac, and becomes the ciliated sac of Huxley. Probably the neural canal of Ascidian larvæ also, of which the cerebral vesicle is a part, is only the rudiment of the canal of the subneural gland. The function of the canal in question is probably olfactory, a supposition favoured by its direct apposition against the ganglion; it is at any rate not excretory, as the ciliary currents set towards the bottom of the sac and not towards the exterior.

Development of Genital Products of Cheilostomatous Bryozoa.†—W. J. Vigelius has found a very suitable object for study in the arctic species *Flustra membranaceo-truncata*, where he finds that the ovary arises from the inner surface of the endocyst, and from that portion of the wall of the distal half of the zoœcium which lies opposite to the side which carries the operculum. Each ovary forms a small spherical or ellipsoidal body of a yellowish colour, which consists of a number of small, round, closely-packed cells. Although apparently isolated, it is connected with the endocyst, the small cells of which take part in its formation. A differentiation is soon seen in the primitively similar elements, for two (or, rarely, more) become distinguished by their size; the other cells become set around these two ova, and the growth of the latter is accompanied by an increase in the size of the follicle, the cells of which apparently increase by division. When the ovarian cells have attained a certain size, there commences a struggle for existence. One grows more rapidly than the other, and the less fortunate one is driven to the periphery of the ovum, where it ceases to grow, although still quite distinctly an ovarian cell;

* Comptes Rendus, xciv. (1882) pp. 988-91.
† Biol. Centralbl., ii. (1882) pp. 435-42.

where there are more than two ova in one follicle, the same phenomenon obtains, one only continuing its further development. About this time the ovary lies free in the perigastric cavity.

Soon the yolk of the eggs becomes darker and granular, and frequently so contracts that a peripheral space is left between it and the egg-wall; as the nutrient material is used up, the central portion of the follicle gradually becomes clearer and thinner, and by the absorption of the cells a passage is left for the egg. The free egg is rounded or oval, and is generally of some size; its passage into the brood-capsule is probably effected by muscular contractions. The author comes to the conclusion that fertilization does not take place in, but externally to the ovicells. Hermaphrodite zoœcia were rarely observed; but when they were, the arrangements were such as to point to self-fertilization. The eggs would seem to be developed independently of the polypides.

The testes appear to be developed later than the ovaries, and not at a definite point of the zoœcium; they are irregular in form, and consist of masses or cords of rounded darkly-pigmented cells, very similar in appearance to those of the primitive ovaries; the male zoœcia are less numerous than the female.

The author thinks that there can be no doubt that the Bryozoa have a general phylogenetic relation to the Rotifera, Mollusca, Chætopoda, and Gephyrea (the Trochosphere-larva, Balfour); in their oogenesis they have most marked resemblance to the Chætopoda and Gephyrea.

Arthropoda.

Brain of Crustacea and Insects.*—J. Bellonci, in an account of the nervous system of *Sphœroma serratum*, whose brain appears to be intermediate between that of Decapod Crustacea and that of Insects, insists on what Berger and Claus have already shown, viz. that the lateral enlargements of the brain of the higher Crustacea are not, as Dietl supposed, the optic lobes, but that the optic ganglion is the true optic centre and altogether corresponds to the optic lobes of insects. In fact, in *Sphœroma*, as in *Nephrops*, the lateral swellings of the median cerebral segments are the centres of origin for delicate fibrils which belong to the antennary (interior) nerves, and they correspond, both in relation and structure, to the antennary swellings of the brain of insects. So again, in Crustacea just as in Insects, the fibres from the optic lobes penetrate between these swellings and the superior lobes: and, if we consider that the swellings of the nerve of the external antennæ are formations peculiar to the Crustacea, we see that in them the lobes containing the olfactory "glomeruli" have just the same relations to the œsophageal commissure as the same parts in insects. The parts which, in the Crustacea, are really homologous with the fungiform bodies of insects are the internal lobes of the superior cerebral segment.

The author supports his views by an account of the structure of the brain of *Gryllotalpa;* at the same time he recognizes the marked

* Arch. Ital. de Biol., i. (1882) pp. 176–92.

differences in the size and histological constitution of these regions which point to a much more elevated psychical function in insects. The great development of the swellings of the median cerebral segment in the higher Crustacea indicates that this region is very important from a psychical point of view. The further details of the structure of the brain and sensory organs of *Sphæroma* would require a number of figures for their satisfactory elucidation.

a. Insecta.

Want of Cutaneous Absorption in Aquatic Coleoptera.*—L. Frédéricq placed *Dytiscus marginalis* and other water-beetles in aqueous solutions of curare, or strychnine, a few drops of which were sufficient to poison a frog in a few minutes. The insects, however, lived in them for from 15 to 30 days, when the experiment was brought to an end. It is to be noted that Coleoptera may be poisoned by strychnine or curare, and the facts observed agree with the statement of F. Plateau that aquatic Coleoptera do not suffer from immersion in sea-water.

Habits of Ants, Bees, and Wasps.—Sir John Lubbock recently laid before the Linnean Society his tenth communication on this subject, containing an account of his further observations made during the past year.

The two queen ants which have lived with him since 1874, and which are now, therefore, no less than eight years old, are still alive and laid eggs last summer as usual. His oldest workers are seven years old.

Dr. Hermann Müller, in a recent review, had criticized his experiments on the colour-sense of bees; but Sir John pointed out that he had anticipated the objections suggested, and had guarded against the supposed source of error. The difference was, moreover, not one of principle, nor does Dr. Müller question the main conclusions arrived at or doubt the preference of bees for blue, which, indeed, is strongly indicated by his own observations on flowers.

Sir John also recorded some further experiments with reference to the power of hearing. Some bees were trained to come to honey which was placed on a musical box on the lawn close to a window. The musical box was kept going for several hours a day for a fortnight. It was then brought into the house and placed out of sight, but at the open window, and only about seven yards from where it had been before. The bees, however, did not find the honey, though when it was once shown them they came to it readily enough. Other experiments with a microphone were without results. Every one knows that bees when swarming are popularly (and have been ever since the time of Aristotle) supposed to be influenced by clanging kettles, &c. Experienced apiarists are now disposed to doubt whether the noise has really any effect; but Sir John suggests that even if it has, with reference to which he expressed no opinion, it is possible

* Bull. R. Acad. Belg. Sci., iv. (1882) pp. 212–3.

that what the bees hear are not the loud, low sounds, but the higher overtones at the verge of or beyond our range of hearing.

As regards the industry of wasps, he timed a bee and a wasp, for each of which he provided a store of honey, and he found that the wasp began earlier in the morning, and worked on later in the day. He did not, however, quote this as proving greater industry on the part of the wasp, as it might be that they are less sensitive to cold. Moreover, though the bee's proboscis is admirably adapted to extract honey from tubular flowers, when the honey is exposed, as in this case, the wasp appears able to swallow it more rapidly. This particular wasp began work at four in the morning, and went on without any rest or intermission till a quarter to eight in the evening, during which time she paid 116 visits.

Larvæ and Pupæ of Diptera.*—In continuation of a former memoir,† Head-forester Beling describes the metamorphoses of 39 species of flies belonging to the families Tabanidæ, Leptidæ, Asilidæ, Empidæ, Dolichopidæ and Syrphidæ. He concludes by giving an analytical table, occupying four pages, in which the characters of the larvæ of 21 genera are contrasted in accordance with the dichotomic method.

Organs of Flight in Hemiptera.‡—L. Moleyre prefaces a statement of the result of his observations by pointing out that in most Hemiptera the part played by the anterior and posterior wings during flight is almost equally important. But the former (hemielytra) are usually horny, whilst the latter remain quite membranous. Each of the two pairs of wings having a distinct structure and capacity, it is indispensable that they should supplement one another and that perfect solidarity should exist between them in their different movements. The apparatus which serves to attach the wings to the hemielytra consequently acquires, from a physiological point of view, exceptional importance. Accordingly he has undertaken an examination of its conformation in the different groups of Hemiptera.

In the Cicadidæ the connecting apparatus is simplest. In them, as well as in *Fulgora* and some allied genera, the posterior margin of the hemielytron is folded underneath, starting from the middle, a deep furrow being formed, in which, at the moment of flight, a corresponding fold of the wing fits. In *Fulgora* the folded portion of the wing begins to be differentiated.

In the Membracidæ, the Cercopidæ, and the Iassidæ, the fold is reduced to a sort of plate inclined backwards on the plane of the wing, often bent into a semicircle and furnished at the extremity with fine serrations.

In the sub-order Heteroptera, it is the fold of the hemielytra, and not that of the wings, which is differentiated. There is also a connecting apparatus which is only found in certain families of Homoptera. In the groups where it attains its greatest development, it appears to

* Arch. f. Naturgesch., xlviii. (1882) pp. 187–240.
† Ibid., xli. (1875).
‡ Comptes Rendus, xcv. (1882) pp. 349–52.

be independent of the principal apparatus, and seems to act under special conditions.

In the Cercopidæ, whose wings present at the base of the anterior margin a triangular enlargement, the external side of the triangle is armed with a row of hooks, few, but very strong, whose extremities, sharply bent, are directed backwards. These hooks are also seen in the Tettigoniidæ and in *Ledra* where they are very small.

In some Membracidæ there are vestiges of these hooks in the shape of long straight hairs, inclined backwards. It is important to note that in *Thelia expansa*, which has only two or three of these hairs, they occupy the widened region of the edge of the wing.

In *Cicada* and *Fulgora*, the principal connecting apparatus is continued as far as the base of the wing by a sort of marginal nervure, forming a very strongly marked rim.

Many of the Hemiptera fly but rarely; the flight of the Hymenoptera, more powerful and better directed, is therefore much more sustained, and from this comparison most naturalists seem to conclude that the organs of flight in the latter exhibit the highest degree of perfection. The author thinks, however, on the contrary, that the double function of the hemielytra, which serve at the same time both as wings and for sheaths, involves special complication in the form of the organs of flight.

β. Myriapoda.

Diversity of Type in Ancient Myriapods.*—S. H. Scudder discusses the systematic position of *Palæocampa* (Meek and Worthen), and comes to the conclusion that it is neither the caterpillar of a lepidopterous insect nor a worm, but a myriapod of a new and strange type.

This brings us face to face with two remarkable facts: First, that in this ancient myriapod, carrying us back as far as any traces of wingless tracheate arthropods have been found, and therefore presumably not far from the origin of this form of life upon the earth, we find dermal appendages of an extraordinarily high organization, more complicated than anything found in living arthropods, excepting the more varied scales of several orders of hexapods; a form of appendage which it would seem, on any genetic theory of development, must have required a vast time to produce, but which we now seem to find at the very threshold of the apparition of this type of arthropod life. Second, that at this early period, in marked contrast to what we find in other groups of articulated animals, the divergency of structure among myriapods was as great as it is to-day. The structural relations of myriapods and hexapods render it probable that the former preceded the latter; and in complete accordance with this expectation, the structural relations of the oldest fossil myriapods indicate their apparition at a period earlier than that to which the winged insects are hypothetically assigned. This would compel us to consider the earlier type as aquatic, for which we have presumptive evidence in

* Amer. Journ. Sci., xxiv. (1882) pp. 161–70.

the structure of the Euphoberidæ, and renders it all the more surprising that the penetrating researches of the last thirty-seven years, since the first Carboniferous myriapod was discovered, have not yielded the slightest trace of fossil myriapods below the coal-measures. This discrepancy between fact and hypothesis should, the author considers, stimulate to more searching investigations, particularly of those articulates of the older rocks whose affinities have not been satisfactorily settled.

γ. Arachnida.

Observations on Scorpions.*—Professor Ray Lankester finds that in the scorpions there exists a similar pair of large coxal glands, having essentially the same structure and position as the coxal glands of *Limulus*. It does not seem possible to doubt that these are homologous structures. Though no external opening has been found as yet, in either the one case or the other, it is possible that such an opening exists. Though glands in a similar position (at the bases of the limbs or jaws) are found in other Arthropoda, there are none known which agree so closely in position and structure with either the coxal glands of *Limulus*, or of *Scorpio*, as these do with one another. Possibly such coxal glands are in all cases the modified and isolated representatives of the complete series of tubular glands (nephrida) found at the base of each leg in the archaic arthropod *Peripatus*.

The discovery of the existence of such corresponding organs goes a long way towards confirming the conclusion as to the close affinity of *Scorpio* and *Limulus* to which Professor Lankester had been led by the observation of numerous other structural coincidences.

Professor Lankester also adds a note † on the differences in the position of the ganglia of the ventral nerve-cord in three species of scorpion, in which he shows that an important anatomical difference obtains between the scorpions with triangular sternum (*Androctoni*) and those with pentagonal sternum (*Euscorpii*, *Buthi*, &c.). Whether the scorpions with bandlike sternum (*Telegoni*) differ from or agree with either of these types in respect of their nervous system, has yet to be discovered.

Insecticolous Acari.‡—A. Berlese first deals with *Hypopus*, and confirms the doctrine of Mégnin that these animals are heteromorphous nymphs of other *Sarcoptidæ*, and the same seems to be true of *Homopus*, *Trichodactylus*, and others; the pedunculated Uropoda are shown to be nymphs, and it is laid down that no Uropod can be judged to be adult until the presence of the genital operculum has been demonstrated. A number of adult *Acari* may attach themselves to insects, but, as a general rule, these migratory forms are not adult. Migration would appear to be determined by desiccation and starvation, and insects to be the principal agents in the rapid and extended diffusion of the *Acari*.

* Proc. Roy. Soc., xxxiv. (1882) pp. 95–101 (1 fig.).
† Ibid., pp. 101–4 (3 figs.).
‡ Arch. Ital. de Biol., i. (1882) pp. 279–81.

Sense-hairs of the Hydrachnida.*—Dr. G. Haller has obtained the material for his investigations from the Lake of Geneva, a locality which has already † added considerably to our knowledge of the systematic zoology of the group.

Olfactory hairs.—In *Atax* the long hairs of the first pair of legs occur chiefly on the lower and outer surfaces of the 2nd, 3rd, 4th, and 5th joints, and diminish in length towards the latter joint. They are sword-shaped. Almost all of them are inserted within certain excavated eminences of considerable size, which protect the base of the hair, while allowing of its free movement, and contain the ganglion from which proceeds the nervous twig which supplies the hair. The hair is traversed by a central cavity which opens to the exterior near the point by an extremely attenuated canal; a number of similar fine canals leave the central cavity, and open at the extremities of some fine teeth which fringe the posterior side of the hair. The function is probably olfactory, and thus the first pair of legs in *Atax* is equivalent physiologically to an antenna. Similar hairs occur in *Axona*, and on the two hind pairs of legs, as well as on the first, in *Atax* itself.

Scales and tactile hairs.—On the hinder and interior surfaces of the palps, where these hairs are absent, they are replaced by certain scales and tactile hairs. The former are very widely distributed among the *Acaridæ*, and in some *Oribatidæ* occur over the whole body as well as the extremities, or they may be confined to the body or to certain parts of it, or, as in *Atax*, to the extremities. In *Atax crassipes* they occur only in the first pair of legs, at considerable intervals, on the 2nd to the 5th joints; they have a lancet-like shape; the cavity branches and opens in the same way as that of the olfactory hairs, although in *Atax* the margin does not present the same thorn-like points for the canals to open into. Nerves have been observed in connection with the canals. The function of the scales is probably also olfactory.

Of the tactile hairs, already described by Haller elsewhere, two new forms are described. The hook-shaped form ends in a fine head, and is now stated to be connected with a nerve-fibre. The length and thickness remain constant in the same species, but vary enormously in different Acarids, the long and stout bristles of the ultimate and penultimate joints in the two anterior limbs of the *Dermaleichi* and *Atax*, and the short and weak hairs of the penultimate joint of the maxillary palps, being referable to the same type; a ring of very short hairs surrounds the margin of the body of *Uropoda clavus*.

The second form of tactile hair occurs only in a representative of a new genus, *Forelia*, from the Lake of Geneva; it occurs exclusively in the male, and is aggregated in large quantities, covering considerable areas; it may be either a short, slightly curved hair on a small chitinous eminence which is penetrated by a nerve-fibre, or such a hair may be accompanied by another of about half its length; locality, the end of the foot of *Atax*.

* Archiv f. Naturges., xlviii. (1882) pp. 32–46 (1 pl.).

† See Lebert's researches, this Journal, iii. (1880) p. 69.

The *antenniform* hair of Hydrachnida occurs at the anterior end of the body or, less frequently, on the back, in front of the insertion of the first pair of legs. It is very mobile, and is placed on a small eminence which is hollowed out so as to form a complete socket for its base; morphologically, it evidently represents the weak hairs which lie at the sides of the orifices of the cuticular glands of the back, as the duct of one of these glands opens close to it. The central canal does not send out fine tubes to the surface, as in the case of the olfactory hairs, but ends blindly; hence the function is probably simply tactile.

An *auditory* function is assigned, chiefly by a process of exclusive reasoning, to some very simple long bristles, pointed and pale in colour, which occur at long intervals on the legs. In *Eylaïs* a dagger-shaped hair with delicate fringing filaments clothes in great abundance the space between the epimeræ of the first four legs; it is supplied by a nerve on which a ganglion is placed within the ring which surrounds its base. Some stout, short hairs, placed on the upper edge of the labium in *Hydrodroma rubrum*, &c., resemble tactile organs, but are possibly, from their position, *gustatory*.

The spined elevation of the lower side of the second joint of the palp of *Limnesia* is, probably, simply intended to meet the opposed claw of the mandible, and is not specially sensory in its properties. The chitinous nail-like tips of the palps of the species of this order, must also be regarded only as grasping organs.

δ. Crustacea.

Ontogeny of Fresh-water Copepoda.*—J. A. Fric gives (in somewhat difficult French) a preliminary note on the ontogeny of fresh-water Copepods, principally confined to the genera *Cyclops*, *Diaptomus*, and *Canthocamptus*. Although it might be thought there was no room for further work in the apparently exhausted field of the anatomy and development of the Copepods, he found on the contrary a considerable number of facts hitherto unexplained.

The nervous system (brain, œsophageal collar, and ganglionic chain) and the alimentary canal are discussed in detail. In regard to nutrition and circulation the author refers to the fact that in this respect the Copepods formed an exception, hitherto unexplained, amongst the Crustacea. The nutritive liquid is set in motion, as is known, either by the heart, or by the regular alternations of the alimentary canal, in cases where the heart is not developed. But the blood-corpuscles, which are so numerous in the Phyllopods, have not, until now, been observed in any Copepod. Claus himself says, "It is remarkable that cellular elements (in the blood) are wanting, whilst they appear in such abundance in the allied Daphnidæ, and I have never been able to see blood-corpuscles even in the large, transparent, marine species."

It is now easy to understand why the lymphatic corpuscles have not been observed in the Copepods: they do not exist in the usual

* Zool. Anzeig., v. (1882) pp. 498-503.

form—forced in a mass with the nutritive liquid through the plexuses of the body—but they glide almost in the form of parasitic amœbæ over the muscles and the organs, nourished by the liquid of the body. In this form the author has observed them in *Cyclops* without a heart, as well as in the Calanidæ (*Diaptomus*) which have one; it is therefore very probable, or even certain, that they exist in the whole of the Copepoda. They are mesoblastic cells in movement during the whole of life, which participate, from their earliest stages, in the formation of the muscles and genital canals.

It is proposed to divide the genus *Cyclops* into two natural groups. The principal differences exist in the larval states of the nauplius and metanauplius, in which the characters are so different and so marked at first sight, that the possibility of a mistake is entirely excluded. The principal difference consists in the organization of the limbs.

In one of these groups—the Dolichopoda—which is evidently the oldest, all the limbs serve for locomotion, and only a few spines on the second and third pairs are for seizing nourishment. The second group—the Brachypoda—on the contrary is more perfectly organized; it is especially the third pair which is bent in the form of maxillæ and adapted exclusively for seizing nourishment. The spines also, at the base of the antennæ of the second pair, are adapted for this function. Whereas in the first group all the limbs extend far beyond the margin of the body, and the third is furnished with a long natatory branch, in the other group they are very short and robust, with the natatory appendage on the mandible very rudimentary.

Aberrant Oniscoids.*—The wood-lice are much neglected by English naturalists. They are well worthy the attention of microscopists who are not able to visit the seaside, and yet desire some path of inquiry affording more promise than the beaten anatomical tracks.

As a sample of what may be done in this direction we note a memoir by Dr. Max Weber on *Haplophthalmus* and *Trichoniscus*, genera enrolled in the exceptional sub-family of Trichoniscidæ. The structure of *Trichoniscus*, save in regard to externals, had not before been investigated. The copious details which such an essay contains must necessarily be studied in the original. Points of general interest, affecting other isopods, are duly indicated.

Dr. Weber makes a digression, more than eight pages long, on the subject of chromatophores. Leydig first showed that in the same situations as chromatophores are found cells without pigment, but otherwise similar, the whole forming one common system. Also animals of constant tint possess non-contractile cells, presumably homologous with chromatophores. Nerves are unquestionably distributed to the chromatophores. By means of gold chloride Dr. Weber has proved this connection in the case of a common isopod (a young *Philoscia*). Anger, fear, love and other emotions undoubtedly cause animals with chromatophores to change colour; yet it is usually assumed that the play of the chromatophores serves to hide their possessor, and perhaps in some cases for protection. But Leydig saw

* Arch. f. Mikr. Anat., xix. (1881) pp. 579–648 (2 pls.)

tree-frogs, amid their natural surroundings, change spontaneously their beautiful green for a dirty grey tint, just as they are known to do in captivity, especially during murky weather. The inference follows, that a depressed temperature here acts on the chromatophores, particularly when we consider that these organs are an appanage of pœcilothermous animals. We learn from v. Platen, Moleschott, and Fubini, that light acting directly on the skin (apart from what is termed the chromatic function, or the indirect influence of light through the eyes) enhances the metamorphosis of tissue. Dr. Weber concludes that one use at least of the chromatophores is to diminish the transparency of the skin, and thus lower the action of even moderate light when it begins to affect injuriously the organism.

Blind Subterranean Crustacea in New Zealand.*—The existence of blind Edriophthalmatous Crustacea in wells and subterranean cave-rivers in Europe has long been known, and now Mr. C. Chilton describes some new forms found in New Zealand. They were obtained from a well at Eyreton, about six miles from Kaiapoi, North Canterbury; the well had been excavated about seventeen years previously, was not more than twenty-five feet deep, and was fitted with a common suction-pump through the medium of which these new forms were obtained. These proved to be three species of Amphipoda and one of Isopoda. In none were there to be found in either the living or recent specimens the least trace of eyes. The isopod is referred to a new genus *Cruregens*, and is most remarkable from the fact that it has only six pairs of appendages to the seven thoracic segments, whilst the normal number should be seven. In many isopods the young have at first only six pairs of legs, the last thoracic segment being but slightly developed and destitute of appendages, and hence at first sight it might appear that the new form was but an immature state. Mr. Chilton, however, states that he has examined altogether twenty live specimens, none of which seemed otherwise to have anything immature about them, and these were obtained at various times from January to October 1881; he would, therefore, refer the absence of the seventh pair of appendages to an arrest of development. In some respects the new genus resembles *Paranthura* of Spence Bate. The new species is named *C. fontanus*. The amphipods found with the isopod are *Cragonyx compactus* sp. nov., *Calliope subterranea* sp. nov., and *Gammarus fragilis* sp. nov., all without eyes. The new species are all figured and at great length described.

Vermes.

Synthetic Annelid.†—A. Giard describes *Anoplonereis herrmanni*, a commensal of *Balanoglossus*, which appears to belong to the Lycorodidæ. But there are three tentacles, the proboscis is altogether unarmed, and there are no jaws or paragnathi. The feet are all of the same characters, the notopodium being provided with a single process, and armed with simple capillary hairs. Characters of this

* Trans. New Zealand Instit., xiv. 'Nature,' 1882, pp. 542–3.
† Comptes Rendus, xcv. (1882) pp. 389–91.

kind distinguish this new form from any other Lycorid, while the appearance of the parapodia recalls what is seen in the Hesionidæ and certain Syllidæ; in addition to this the presence of the third central antenna is a Syllidean character. On the whole, therefore, *Anoplonereis* unites the Lycorididæ with the Hesionidæ and Polynoidæ on the one hand, and on the other with the Syllidea, which may be considered as being the ancestors of the whole group of Nereids, when that term is taken in a wide sense.

Elytra of Aphroditacean Annelids.*—Mr. W. A. Haswell has investigated the structure and functions of the elytra or scales, the possession of which is one of the most characteristic peculiarities of the Aphroditacea.

With regard to the functions of the elytra the author distinguishes (1) protection, (2) production of phosphorescent light, (3) sensation, (4) respiration, and (5) incubation.

The protective function is in some cases the predominating one. Thus in *Iphione* the scales are of extreme density, and cover the entire dorsal surface with a complete armour. In others, the scales, though tough, are more readily detached, and in many instances do not completely cover the dorsal surface; or are so delicate, and so readily parted with when the animal is irritated, that their direct protective action must be very slight.

When certain species of *Polynoë* are irritated in the dark a flash of phosphorescent light runs along the scales, each being illuminated with a vividness which makes it shine out like a shield of light, a dark spot near the centre representing the surface of attachment where the light-producing tissue would appear to be absent. The irritation communicates itself from segment to segment, and if the stimulus be sufficiently powerful, flashes of phosphorescence may run along the whole series of elytra, one or more of which then become detached, the animal meanwhile moving away rapidly and leaving behind it the scale or scales still glowing with phosphorescent light. The species in which the phenomenon of phosphorescence occurs are species characterized by the rapidity of their movements, and also by the readiness with which the scales are parted with; and it seems not at all unlikely that the phosphorescence may have a protective action, the illuminated scales which are thrown off distracting the attention of the assailant in the dark recesses which the Polynoidæ usually frequent.

That the elytra act, like the dorsal cirri, as organs of some special sense, seems probable from their abundant innervation, as well as from the presence, in many instances, of fimbriæ and other appendages, some of which act as end-organs for the nerve-branches.

In *Aphrodita* and *Hermione* the scales have been observed by Williams and Quatrefages to perform an important mechanical function in connection with respiration. In these genera the dorsal surface is covered with a coating of felted hairs, which stretch across

* Ann. and Mag. Nat. Hist., x. (1882) pp. 240–2. Proc. Linn. Soc. N. S. Wales, vii. (1882) pp. 250–99 (6 pls.).

from one side to the other, and enclose a canal open in front and behind, and having for its floor the dorsal wall of the body with the elytra and the "branchial" tubercles. These authors regard the oxygenation of the perivisceral fluid as taking place through the thin integument covering the scale-tubercles and the tubercles at the bases of the dorsal cirri, and have observed the scales to be subject to rhythmical movements, by means of which a current of water is driven continually over the dorsal surface, thus renewing the water in contact with the "branchiæ." In species in which the felt-like dorsal covering does not exist, this function would appear to be in abeyance; and in *Polynoë* and allied genera, so far as Mr. Haswell has observed, the elytra remain perfectly motionless while the animal as a whole is at rest.

The sexual products reach the exterior through apertures in the bases of the parapodia; and the ova are carried by ciliary action to the under surface of the scales, where they remain, adhering by means of a viscid matter, till the embryos are well advanced. Impregnation probably takes place while the eggs are in this situation.

Phosphorescent Organs of Tomopteris.*—In two new species of this genus of worms, described, from near the West Coast of Equatorial Africa, by Dr. R. Greef, under the names *T. Rolasi* and *T. Mariana*, the so-called "rosette-shaped organs" are represented not as eyes or glands as has been hitherto done, but as organs for producing light. In these species they are formed on the middle of the "rudder" of the parapodia as well as on the floats.

Under low magnifying powers they are seen to form sac-like spaces, enclosing a globose yellow oily mass which ultimately proves to be made up of a number of yellow tubes aggregated like the segments of an orange, thus producing the well-known rosette-like appearance. In *T. Mariana* the organs differ according to their position; those in the floats have the ordinary rosette-characters, but those of the rudders of the two front pairs of parapodia form two large organs occupying almost the entire breadth of the foot, lying near the inner wall of the ventral part; they are rosettes of a deep orange-yellow colour, enclosed in transparent rosette-shaped sacs. The tubes composing the rosette are filled with a granular substance. The organs are supplied with nerves on which ganglia occur over the sacs; from these ganglia proceed fine nerves which penetrate the sacs and reach the rosettes. Each of the segments, 6 to 11 in *T. Rolasi* and 8 to 11 in *Mariana*, exhibits a segmental organ near the point of projection of the parapodium from the body; it consists of a short curved ciliated canal with a large internal and somewhat smaller ventral external opening; the former has a frilled margin, the latter has sharp edges. On the ventral side of segments 4 and 5 in sexually mature females occur a pair of transverse genital slits.

Priapulus bicaudatus.†—R. Horst distinguishes in the cuticle of this Gephyrean two layers, the outer of which is thin and homo-

* Zool. Anzeig., v. (1882) pp. 384–7.

† Niederland. Arch. f. Zool., Suppl. Bd., i. (1882) Gephyrea, 13 pp.

geneous, while the thicker inner one is made up of several superimposed layers; the striking difference between the chemical reactions of the two is pointed out, and the differences in their appearance and structure detailed; to see them best the cuticle of the proboscis should be examined after maceration.

Dermal projections of various kinds are found on different parts of the body; the simplest are the papillæ which are found irregularly distributed on the rings of the trunk; they are blunt conical projections about 0·1 mm. long, are invested by a thin cuticle, and filled by a process of the hypodermis; the cells of the latter form a continuous layer, with the exception of the central portion where there is a meshwork of nucleated fibres. The papillæ on the hinder edge of the last ring are not only distinguished by their greater length, but by the presence within them of a wide-meshed network of extremely fine fibres. Modified dermal papillæ are to be found on the costæ of the proboscis, where they form conical projections, the two lower thirds of which are invested in a kind of shield.

The description of the costæ of the proboscis given by Koren and Danielssen is stated to be incorrect, the glands described by them being merely integumentary canals cut across. Beneath the integument, and between it and the musculature there is at the anterior end of the body a space which communicates with the body-cavity by the intervals between the muscular bands.

Especial attention may be directed to the fact that for its whole length the nervous system is in connection with the ectoderm; it is essentially composed of extremely delicate fibrils covered by thicker fibres united into a plexus and passing into the cells of the hypodermis. Some corrections are made in the account given by the original describers of the female genital organs, and the male organs, which were not described by them, are stated to have the same form and position as the female, but instead of a lamellar they have a racemose structure, and the efferent duct is not superficial but principally internal. The nuclei of the cells were of considerable size, and the finely granular contents are divisible into a cortical and a medullary portion.

Anatomy of Ankylostoma duodenale.*—W. Schulthess gives a detailed description of this Nematoid, the length of which has been so very variously stated by different authors; the present investigator finds it to vary from 6 to 18 mm. After an account of the external form and the differences between the males and females, the writer passes to the integument, the two layers of which are described; in the study of the muscular layer we may distinguish the longitudinal lines, the muscles, and the papillæ; in dealing with the last, attention is directed to two hitherto undescribed structures; on the ventral surface of the male the skin, at one point on either side, is traversed by a fine subcuticular tissue, while in the female two similar structures are to be found near the tip of the tail; the significance of these bodies is only incompletely understood. The digestive tract is divisible

* Zeitschr. f. wiss. Zool., xxxvii. (1882) pp. 163–220 (2 pls.).

into the oral capsule, a highly complicated organ of fixation, an œsophagus and intestine; anal glands can only be definitely said to be present in the male. The author concludes with a history of the genital tract, which, well developed in either sex, is remarkably so in the female, where it would appear to be the cause of the greater size of the body. In a transverse section the genital tube may be cut through at least as many as ten times.

Structure of Trematodes.*—On the lungs of two tigers from the zoological gardens of Amsterdam and Hamburg, Dr. C. Kerbert discovered what he describes as a new species of *Distomum*, *D. westermani*. Two individuals were always found enclosed together in one horny capsule. All the organs of this fluke he has noted with care, and he discusses fully their histological characters. Save that he was not able to trace in his specimens the ciliated funnels at the ends of the finest branches of the excretory canals, as observed by Fraipont in *D. squamatum* and several ectoparasitic trematodes, he gives in the present memoir a complete account of almost every topic concerning the anatomy of trematodes in general.

Dr. Kerbert resolves the entire body of his *Distomum* into two strata, cortical and central. The latter is traversed by the dorsoventral muscles and includes the various internal organs,—nervous, alimentary, excretory, and sexual.

The cortical stratum includes—the cuticle proper, the epidermis, the basal membrane ("cuticle" of authors), the tegumentary muscular layer, and the layer of tegumentary glands.

Two kinds of cells make up the splint-tissue constituting the bulk of the central stratum. The first are membraneless, of irregularly rounded figure, with finely granular contents and a conspicuous excentric nucleus or two nuclei. The other cells are branched; their branches unite to form a spongy network, in the meshes of which the round cells, usually isolated or in pairs, are included. In some places the meshes contain, instead of distinct cells, a protoplasmic residuum with imbedded nuclei. Here and there the trabeculæ appear under the guise of a very well developed fibrillar connective tissue, with fusiform nuclei among the several fibres. Just under the cortical stratum the cells of this connective tissue blend together into one granular mass of protoplasm, the so-called subcuticular layer.

As to the several organs, our space only permits us to notice briefly the sexual. These consist of (*a*) the genital sinus, (*b*) the male, and (*c*) the female organs. The genital pore, or common orifice of the whole apparatus, lies in the mid-ventral line, not very far behind the posterior sucker. The sinus itself is lined by a basal membrane, and is an invagination of the cortical stratum stripped of its epidermis. In general form the sinus is conical, with its apex turned backwards and inwards. The apex leads into the female conduit, or so-called uterus. The male opening is situate anteriorly, on the upper wall of the sinus, at its left side. The two, not quite

* Arch. f. Mikr. Anat., xix. (1881) pp. 529–78 (2 pls.).

symmetrical, irregularly lobed testes are placed dorsally in the hinder part of the animal. Their vasa deferentia unite in due course to form an ejaculatory duct, whose first portion acts the part of a seminal vesicle. Neither cirrus-pouch nor intromittent organ are present.

The female organs are—the ovary and oviduct, the vitellaria, the shell-gland, the canal of Laurer and the "uterus." The unpaired many-lobed *ovary*, somewhat dorsal in position, lies to the right of the ventral sucker. The conical continuous oviduct has its narrow end directed towards the shell-gland; where the oviduct ends the uterus begins. The paired *vitellaria* are made up of (*a*) the vitellarian glands, (*b*) their longitudinal collecting sinuses, (*c*) the two transverse ducts passing from these, (*d*) the rather long pear-shaped reservoir into which the transverse ducts debouch and (*e*) the yolk-duct proper into which it is continued. The *shell-gland*, a dense cluster of unicellular glandules, with interposed connective tissue, invests the innermost section of the uterus, where the yolk-duct and oviduct by their junction give rise to this conduit. Here also *Laurer's canal* arises; making two or three convolutions in its course it at length reaches the dorsal surface, where in the middle line its funnel-shaped opening appears, just in front of the transverse vitellarian ducts. A receptaculum seminis is appended to Laurer's canal not far from its junction with the uterus. The beginning of the *uterus*, hidden amidst the substance of the shell-gland and receiving the three ducts already mentioned, constitutes the "ootyp" of the elder Van Beneden, a term which Dr. Kerbert would extend to the adjoining part of the long winding tube which follows. The coiled vestibular portion of the uterus wholly occupies the space below the transverse vitellarian duct, on one side of the body, between the left diverticulum of the gut and the middle plane. Thus from the genital sinus we pass, by way of the uterus, to all the other female organs, and the whole gynæceum has two openings,—a ventral, leading into the sinus, and a dorsal belonging to Laurer's canal. The minute structure of the parts which make up this complex of glands and passages is described with very great clearness. The share taken by each in the formation or protection of the ova is also explained.

Against the possibility of self-fertilization among trematodes Dr. Kerbert urges many considerations. An internal vas deferens cannot be said to exist. The road by the uterus is not favourable to the transfer of spermatozoa. Most helminthologists, except Sommer, regard Laurer's canal as a vagina, which it is in the strictest sense,—an organ for copulation but not for parturition. The frequent occurrence of trematodes in pairs, the conformation of the body by which the back of one individual is closely applicable to the ventral surface of another, the position of the two external sexual orifices (equidistant in Dr. Kerbert's fluke from the anterior sucker), the presence of spermatozoa in Laurer's canal and their absence from the genital sinus or uterine coils—these are facts which at present favour the view, that the trematodes, if hermaphrodite morphologically, resemble snails and most monoclinous flowering plants in not being self-fertilizing.

Adaptation to Environment in the Trematoda.*—Prof. G. B. Ercolani finds that:—

1. The succession of phases of development is not always the same in all Trematoda; some leave the egg as a ciliated embryo, and require water; others, developed in terrestrial molluscs, have a non-ciliated embryo.

2. Nor are the different phases in development the same for all; the condition of encystation which is necessary for some is omitted in other species, which pass directly from the free *cercaria* into the free *Distomum*. There is, moreover, at least one exception to the rule that the larva must at one stage be agamic.

3. The well-known fact that certain nurses are reproduced by asexual generation (either gemmiparous or scissiparous, and the latter either endogenous or exogenous) was observed not only in simple sporocysts, but also in true *Rédiæ*. A special form of scissiparous generation was observed in the racemose sporocysts, where certain living parts are (as in Bryozoa and Hydrozoa) connected by atrophied stolons.

4. The direct conversion of the tail of a cercaria into a nurse was observed several times.

5. Encystation may not only be normal, but also accidental or abnormal; some die when, and at the place where, this accidental encystation takes place; others become, sometimes completely, but more frequently incompletely, adapted to this modification; in the latter case the generative organs are imperfectly developed, or are not developed at all. Examples of this are to be seen in the adaptation of *Cercaria echinula* to the intestine of the duck, dog, or rat; this species accommodates itself in different ways, so as to present different zoological characters, though these are not sufficiently distinguished one from another to justify the formation of distinct species. On the other hand, *Distomum mentulatum* may present quite definite specific differences.

The doctrine that each species of mollusc has a single determinate species of cercaria, corresponding to a single species of Trematode, is denied, and it is shown that, e.g. *Bytinia tentaculata* has as many as twelve different species of cercariæ. When exogenous gemmation obtains, the buds are produced at the hinder end of the body. While some forms have an excretory apparatus, composed of two vessels converging towards a buccal pore, others have no vessels or pores. As to the number of Distomata in one cyst, we had no definite information prior to the observation of Ercolani that from 20–80 larvæ might be found in large cysts on the peritoneum of tadpoles.

Vascular Organs of Trematoda.†—A. Villot points out that in the Trematoda, as in the Cestoda, there are a large number of canals which traverse the whole of the body, and open by a number of pores, either on the surface or into the intestine. Although they constitute but a single system, they may be divided into (1) a central

* Arch. Ital. Biol., i. (1882) pp. 439–53.
† Zool. Anzeig., v. (1882) pp. 505–8.

portion, represented by a contractile utriculus, which often extends throughout the whole length of the body, and ends at the caudal foramen; (2) a median portion, consisting of branches of a medium size; and (3) a peripheral portion, formed by a capillary plexus which penetrates all the organs and the parenchyma of the body.

In discussing the different morphological interpretations of these parts, the author expresses his opinion that the theory of Prof. Ray Lankester, according to which a portion represents the cœlom and the rest the nephridium, rests on an arbitrary distinction, inasmuch as there is nothing in the Platyhelminthes which corresponds to the internal orifices of the segmental organs of Annelids; nor does the author find the explanations of Fraipont either satisfactory or new. Indeed, M. Villot is of opinion that later works have exhibited rather a step backwards; the presence of a cœlom and of true segmental organs in these worms still remains to be demonstrated; the vascular apparatus consisting of a single system of vessels, which are perfectly continuous and open only to the exterior or into the enteron.

Anatomy of Cestodes.*—Dr. Z. von Roboz has examined *Solenophorus megalocephalus.* In dealing with the cuticular structures, he finds that the cells forming the so-called subcuticular layer are connected both with one another and with the cuticle by a fairly well-developed, finely granulated, intercellular substance, in which fine fibrils of connective tissue are to be distinguished. The constituent cells differ in form in different parts, for, while they are elongated in the older joints, and have a finely granular protoplasm with a distinct nucleus and nucleolus, they are spindle-shaped in the scolex and the younger joints, and are connected by processes with the cuticle on the one hand and the interior of the body on the other; the forms of these processes may vary considerably.

In regard to the water-vascular system, the most interesting discovery of the author would appear to be the demonstration of a special musculature for the longitudinal canals and their branches, an arrangement which seems to have escaped the observation of all previous investigators. The following will give some idea of what has been observed as to the nervous system:—Four nerve-cords are, altogether, given off from the ganglioniform enlargements which pass into one another at the region of the two suckers, and so give rise to the formation of a nerve-ring. Finer branches are thence given off, some of which pass into the suckers, while others give rise to the primary cords which pass into the proglottids; the connection between the nerve-branches is such as to give rise to a nerve-plexus embracing the whole of the scolex.

It has been found that the oviduct is not merely formed by a thin homogeneous membrane, but that it is invested by an epithelium; from the separate cells special hair-like structures, which call to mind cilia, project into the lumen of the tube; but that they are really cilia was negatived by the length of time that the material for examination had been preserved. The vas deferens appears to be formed

* Zeitschr. f. wiss. Zool., xxxvii. (1882) pp. 263–85 (2 pls.).

of a thin structureless membrane, bounded internally by a single layer of cells; the penis has a very thick cuticle, and in *Solenophorus* is of some considerable length.

Studies on Cestodes.*—R. Moniez here treats chiefly of species of *Tænia*. In *T. pectinata* the uterus becomes modified very considerably in the older segments; its cæca become covered with a thick layer of granules which appear to result from luxuriant cellular proliferation of its walls. The granules become detached, and fall into the cavity of the uterus; some of them invest the embryos as a cuticular investment, and the rest form a reticulum which encloses the latter; a similar process takes place in *T. cucumerina*. The vessels in *T. pectinata* form numerous large anastomoses between each other. In another species, resembling *T. expansa*, *T. cucumerina*, &c., a possibly glandular mass is situated upon the oviduct, with cells each exhibiting an immense vacuole. The uterus forms two tubes extending from side to side of the segment, viz. on the ventral and dorsal surfaces, and lying on the muscular layer. When the uterus is full of ova, wide communications are seen between these main divisions. In *T. giardii*, the male organs are placed at the two ends of the segment; the spermatozoa of one side cross the segment and issue by the opposite vas deferens, the two currents crossing on the dorsal side. In young segments the vagina is very large, and the ovary appears by contrast to be merely an appendage of it, but later it envelopes and conceals it. The ovum does not exhibit the vitelline masses which appear towards the end of development in *T. expansa*. Besides the normal muscles are found some large fusiform cells, quite distinct from them, especially abundant in the central zone; in the old segments they are strongly refractive, and devoid of granules; they appear to be homologous with the mother-cells of the calcareous corpuscles. No vitellogenous glands exist in any of the species referred to.

Ligula and Schistocephalus.†—Herr F. Kiessling, working in the laboratory of Professor R. Leuckart, has detailed the structure of *Schistocephalus dimorphus* and *Ligula simplicissima*. He maintains the generic distinction of these tape-worms in opposition to Donnadieu, whose description of *Ligula* (published in Robin's Journal for 1877) he corrects in several particulars. As containing a revised account of two rather aberrant cestoids, presenting many noteworthy points of agreement, this essay has a value of its own; in so far as it deals with anatomical questions concerning tape-worms generally, it supports the views set forth by Herr Kiessling's teacher in the current edition of his great work.

These cestoids, when mature, inhabit the gut of water-birds. While *L. simplicissima*, in its asexual phase, infests malacopterous fishes, the larval *Schistocephalus* is a parasite of the body-cavity of the common stickleback. Both larvæ agree in being injurious to their hosts, so that external inspection reveals their presence. Curiously enough, *Schistocephalus* could not be found throughout a wide area

* Comptes Rendus, xciv. (1882) pp. 661–3.
† Arch. f. Naturgesch., xlviii. (1882) pp. 241–80 (2 pls.).

round Leipzig and Halle; near Berlin every second stickleback had its young tape-worm.

The complex sexual organs of *Schistocephalus* are here made intelligible by very clear figures. Why *Ligula*, as Leuckart has already shown, should differ, bird-wise, in having but one ovary, is not easily explained. In other respects the genitalia of the two worms are very similar. Herr Kiessling insists that there is not a fusion of two ovaries into one, as stated by Riehm to occur occasionally with *Tœnia rhopalocephala*.

New Floscularia.*—Dr. C. T. Hudson describes a new *Floscularia* (*F. regalis*), found by Mr. T. Bolton, on *Myriophyllum* in a pond near Birmingham, which also bore specimens of *F. campanulata*, *F. ambigua* (also one of Mr. Bolton's discoveries), *F. coronetta*, and *F. ornata*.

The new rotifer has a nearly circular cup-shaped disk, the edge of which bears six slightly recurved processes ending in knobs covered with long radiating setæ. The processes taper from their bases up to the knobs, and are set at regular distances round the cup, giving the rim quite a hexagonal appearance. The two processes which are nearest to the dorsal surface are shorter than the others, and between them rises a triangular lobe longer than any of the processes, and also crowned with a setæ-bearing knob. The disk is thus a kind of cross between that of *F. coronetta* and *F. ornata*, only with this hitherto unique distinction, viz. that there are *seven* processes issuing from it. All the previously known floscules have either five or three such processes; and there is only one known species that has the latter number, Mr. Hood's *F. trifolium*. Ehrenberg's six-lobed *F. proboscidea* is no doubt the five-lobed *F. campanulata*.

F. regalis is not one of the larger species. The majority of those hitherto seen were about $\frac{1}{60}$ of an inch, and the largest was $\frac{1}{50}$. The smaller, and probably younger, ones were unusually transparent for floscules. The two eyes were readily found on the dorsal side, both by direct and by dark ground illumination. Dr. Hudson was surprised, also, to find how easy it was to see the semicircle of small cilia which lies at the bottom of the cup on the ventral side. In the majority of the other species these are extremely difficult to make out. On the other hand, the tube of the new floscule was in every instance almost invisible. Its existence could just be made out, but that was all. No great stress ought, however, to be laid on this, as the tubes of all species vary very much according to their habitat. When fully expanded it usually extends outwards all the six linear processes, but curves inward the seventh triangular one over the cup-shaped disk, and uses both it and its setæ to prevent the escape of its prey.

Desiccation of Rotifers.—The Rev. Lord S. G. Osborne referring to a previous letter of Mr. Jabez Hogg as to the Rotifers and *Amœbœ*

* Midl. Natural., v. (1882) p. 252.

revived from "earth" taken from Durwaston, says* that it was simply the dust of the garden which happened to deposit itself in certain cup-like receptacles made artificially of a substance which coated itself with an oxide, giving to the dust when wet a rusty appearance. After having been in a drawer for more than three years no symptom could be detected of a decrease in the number or activity of the stock. He adds, "It is to me inexplicable that although I have collected very many specimens of the rotifer (*R. vulgaris*) from plants taken from ponds, I never could acclimatize these in my tanks, so that they would bear the drying process so successfully as when procured after my own fashion."

Echinodermata.

Heteractinism in Echinodermata.†—In dealing with a small collection from Point de Galle, Professor F. Jeffrey Bell describes a specimen of *Ophiomastix annulosa* in which one arm measures as much as 300 mm. in length, and gives an account of another example, which, as he calculates, may have had a total spread of 800 mm., or nearly 32 inches. He points out that such a form must be continually subjected to the loss of part of an arm, but that owing to vegetative repetition the loss will hardly perhaps affect the individual, and not at all the species. Contrary to the opinion of such observers as Haeckel and Simroth, he holds that such external irritation is not to be neglected in discussing the question of heteractinism. There would appear to be in all echinoderms a capacity for self-injury, which, in these days, is excited by pain, fear, or anger; while the starfish may only throw off an arm, an ophiurid, in consequence of its greater centralization, undergoes fission of the disk. The disk thus injured may give birth to more arms than it has lost; and when this habit becomes inherited, we may get six-rayed forms; such are to be found in *Ophiacantha*, where, in some cases, there is so well-marked a cenogeny that, not only are the adults sex-radiate, but the young are developed viviparously, and never exhibit any bilateral symmetry.

The origin of this tendency to self-mutilation is ancient and deep-seated, for some polyactinic forms (*Brisinga*) lose their arms for the purpose of setting free their genital products; the tendency would seem to be lost in those which, by the power of the spines, are able to resist all foes, or those which by their capacity for vegetative repetition are enabled to atone for it. When the tendency is seen in others it has quite a different physiological significance, for the result is true asexual reproduction.

Considerably modifying a table once given by Haeckel, Professor Bell points out that in the Echinodermata we may have—

A. Sexual reproduction.

- α. With metamorphosis ("metagenesis and internal gemmation").
- β. Without metamorphosis (viviparous Echinodermata).

* *Times*, 4th October, 1882.

† Ann. and Mag. Nat. Hist., x. (1882) pp. 218–25.

B. Asexual reproduction.

α. Fission, with repair.

β. External gemmation from a single arm.

In certain cases heteractinism would appear to be due to increased activity, consequent on inflammation.

Circulatory Apparatus of Regular Echinoids.*—R. Koehler describes the presence of two circular circumœsophageal vessels, and of two vessels in each ambulacral zone; he also proves the complete independence of the nervous and circulatory systems, and finds that this last communicates with the excretory organ by means of the sand-canal. The sand-canal is not simple, but is really formed of two, which are closely connected together; the only one which has as yet been described is independent of the ovoid gland of Perrier, or the organ of excretion, while the other is connected with it. Transverse sections of the sand-canal reveal the presence of one tube regularly lined by epithelium, and of another whose lumen is partly filled by bars of connective tissue which form a delicate reticulum supporting protoplasmic cells. The second canal, when it reaches the ovoid gland, increases in diameter, the partitions in its lumen become more numerous, while the gland itself consists, as in irregular Echinoids, of trabeculæ of connective tissue which are very delicate, and have their alveoli filled with protoplasm and pigmented bodies. The two circumœsophageal vessels communicate with one another at the level of the Polian vesicles.

Structure and Development of Ophiuroids.† — K. Nicolas Christo-Apostolides has at length published, in the French language, the full text of his memoir on Ophiuroids, with six plates. While availing himself of modern aids to histological research, he enjoyed the advantage of a copious supply of living specimens, and he rests his claims on the circumstance that he made good use of these as well as of preparations.

Five genera, including eight species, were examined. Not much is said of the skeleton and body-wall in the adult animal. The soft parts are minutely analyzed.‡ The simple sac-like alimentary canal, without mesenteries or free glandular appendages, consists of four separate layers—(*a*) an internal ciliated epithelium, (*b*) a brown layer with long (muscular) fibres, (*c*) a cellular (secretory) layer and (*d*) an investment of connective tissue. In this last are found peculiar triradiate calcareous spicules, the free ends of whose rays become again triradiate. There is a distinct, though short, œsophagus. The larval form has an anus, wanting in the adult.

Imprisoned brittle-stars, eight or ten days after being captured, show an opening in the middle of the back. Our author believes that, in consequence of starvation, a sinking of the dorsal wall takes place; this, with the central portion of the gut, becoming engaged among the five oral pieces, is bitten off as a substitute for food.

* Comptes Rendus, xcv. (1882) pp. 459–61.

† Arch. de Zool. Expér. et Gén., x. (1882) pp. 121–224.

‡ See this Journal, i. (1881) pp. 466 and 606; *ante*, p. 199.

The existence of a circulatory system is denied, apart from the water-vessels and the general lacunæ of the body; albeit that these lacunæ are so disposed between the various internal organs, or these and the integument, as to present a certain definiteness in their arrangement. The true madreporic tube is figured with the pyriform gland (hitherto mistaken for a heart) placed beside it, the two being enclosed in a common investment strengthened with calcareous pieces and constituting the sand-canal of authors. The circular water-vessel of the larval brittle-star is closed from the first. Our author does not fully explain how it comes to surround the gullet. He simply says that the aquiferous system encroaches upon the digestive tube. Probably it slips over the rudimentary gut soon after the disappearance of the anus. The tubular ring, at an early period, sends forth five rays, each of which again gives off five cæca. Of these cæca the central one becomes the longitudinal ambulacral vessel of the arm; the adjoining cæca supply the first pair of tentacles; the two outer cæca represent the superior pair of buccal tentacles, whose common trunk elongates and produces the second pair. At first all five cæca have their points outwards; at a later stage the buccal pair turn in to face the mouth. The young Polian vesicle at first, also, grows from the circumference of the ring towards its centre; subsequently this direction is reversed. Not all brittle-stars have Polian vesicles. They are absent in *Ophiothrix versicolor*, which is thus distinguished from the common *O. rosula*, as likewise by its less convex arms and more variable tints.

While in certain Ophiuroids, e. g. *Ophioglypha*, the genital organs are appended to the respiratory pouches, as Ludwig has described them, they are in others more or less distinct. They are so far independent in *Ophiocoma nigra* that, when this species is dissected with its dorsal aspect upwards (in its natural position) the respiratory sacs must be removed before the genitalia can show themselves. In *Ophiothrix* each cluster of genital "glands" is replaced by a single organ.

The development of the Ophiuroids is described in the case of two species, *Ophiothrix versicolor* and *Amphiura squamata.* The first represents that section of the group in which there is an early oviposition and metamorphosis of the young; while *Amphiura*, further exceptional in being hermaphrodite, is viviparous. Nevertheless the organogeny of these two brittle-stars presents many more points of agreement than of difference. The resemblance of the free larva to the pluteus of the *Echini*, on which so much stress has been laid, is to be regarded as more superficial than real, and comparatively simple larval forms may occur beside those whose very striking transitory appendages render them rather abnormal than otherwise. The researches of Metschnikoff, the only observer since Müller who has contributed much to our knowledge of this subject, should be compared with those of our author. In many features the development of the Ophiuroids essentially approximates to that of the true star-fishes, as first described with adequate fullness in the beautiful memoir for which we are indebted to the younger Agassiz.

On three important topics, demanding renewed inquiry, the

author differs from most embryologists. He supports (against Ludwig) the view, formerly urged by Lyman, that the oral skeleton is not made up of modified proximal elements of the arms, since it has an earlier and independent origin. The alimentary canal he describes as formed by delamination, not by invagination as in other echinoderms. Lastly, he contends that the two (rarely three) rudiments, from one of which the future water-system is derived, do not arise as diverticula of the digestive tube, but from cells which lie between it and the ectoderm of the embryo.

Formulæ for Comatulidæ.* — Professor F. Jeffrey Bell in an "Attempt to apply a method of formulation to the species of the Comatulidæ," deals with the two large genera *Antedon* and *Actinometra;* these two forms he proposes to distinguish by the signs A and A′; while for the brachials, distichals, and palmars he uses the letters B, D, and P, whenever their respective axillary forms a "syzygy"; according as the first, second, or third brachial is a syzygy he adds the number 1, 2, or 3. Dealing with the cirri and their joints he divides both into three sets of few, moderate, or many; these are distinguished by the letters a, b, and c, the cirrus-mark being placed above and the joint-mark below the fraction sign. A ten-rayed *Antedon* with 15 cirri of 40–50 joints, with the first syzygy on the third brachial, has its formula written $3\,A\,\frac{b}{c}$; a multiradiate *Actinometra* with its radial and palmar (though not its distichal) axillaries syzygies, with a syzygy on its first brachial, with less than 13 cirri and more than 40 cirrus-joints, has the formula $1\,A'\,R\,P\,\frac{a}{c}$. When a character is not constant it is placed in brackets, and when a multiradiate species has not any axillary in R, D, and P, its formula is placed under the mathematical sign of the square root.

Holothuroidea of the Norwegian North Sea Expedition.†—In another magnificent contribution to the fauna of the Arctic Seas, D. C. Danielssen and J. Koren describe in detail the new forms of which they have already published diagnoses. Of the seventeen genera in the collection five were new, and of the twenty-five species, six were new. *Kolga hyalina* is remarkable for the absence of fibrillar tissue from the subepithelial connective tissue, an arrangement known in no other Holothurian; the calcareous ring is very imperfectly developed, and the sand-canal presents an embryonic condition in still remaining open; the bilateral symmetry of this form does not, in the opinion of the authors, weigh sufficiently against the totality of their organization, to justify us in placing it high in the scale. In *Trochostoma thomsonii* well-defined vascular plexuses were seen in the wall of the rectum, but they do not seem, as in some insects, to have a respiratory function, but to serve as a system of lymphatic vessels. Two respiratory tubes are connected with the intestine, but there is no proper cloaca; the madreporite is remarkable for its position, being

* Proc. Zool. Soc. Lond. 1882, pp. 531–6 (1 pl.).
† Norske Nordhavs Exp. 1876–8, vi., Zoology, 4to, 90 pp. (13 pls. and 1 map).

placed on the canal, but not at its extremity. *Ankyroderma* appears to be transitional between the Synaptidæ and the Molpadidæ.

Histology of Digestive Canal of Holothuria.*—E. Jourdan finds, in *Holothuria tubulosa*, that the cells of the epithelial or peritoneal layer are of two kinds; simple endothelial cells arranged in a single layer, cylindrical in form and often ciliated, while the others are of the type of mucous cells. The muscular layer is formed by circular and by longitudinal fibres, the former being continuous and regular, while the latter are most numerous in the anterior region of the tract, while, again, they are placed internally to the circular muscles anteriorly, and are external to them posteriorly. A number of lacunæ are to be found in the connective layer. The cells of the internal epithelial layer differ remarkably in different regions; while they are at first excessively long, and have the form of delicate fibrils, they are, further from the mouth, distinctly cylindrical. The glandular cells with granular contents are ovoid or spherical and appear to be confined to the more anterior regions, while the so-called mucous glandular cells are more widely distributed, with, however, considerable variations in their form, size, and number; in the more posterior portions of the intestine they may be compared to the mucous cells of the Vertebrata.

Cœlenterata.

Studies on Cœlenterates.†—Dr. O. Hamann finds that the cnido-cells are interstitial cells which have developed an urticating capsule in their interior and have then passed from the lower to the more superficial layer of the ectoderm; it may be shown by the presence of the nucleus after the formation of the capsule that this last owes its origin to the protoplasm of the cell. At the same time the cell is capable of producing a process which becomes connected with the supporting lamella, and has many if not all of its characters; this process is not a mode of communication from the exterior to the interior of the organism, but only a supporting fibre; if this view be the correct one it is clear that the cnido-cells cannot be looked upon as having a sensory function, but rather as being partly defensive and partly offensive.

In discussing the pseudopodioid cells of *Hydra* it is remarked that, if we examine the region of attachment we find that the ectodermal cells are here different from what they are in other parts of the body; cylindrical in form, their contents are not clear but finely granular; if separated, after maceration, they are seen to have only one and not two of the so-called muscular fibrils; and if carefully studied in the living specimen they may be seen to be capable of excreting mucus; if examined, when the animal is in movement they may be shown to protrude pseudopodia. No interstitial cells or cnido-cells are to be found in this region. The apparent absence of pseudopodioid cells in all other Cœlenterates leads the author to believe that *Hydra* is really a form standing very close to the ancestor of the Hydroid Polyps; though he recognizes the possibility of the objection being raised that *Hydra* has lost its skeleton in fresh water.

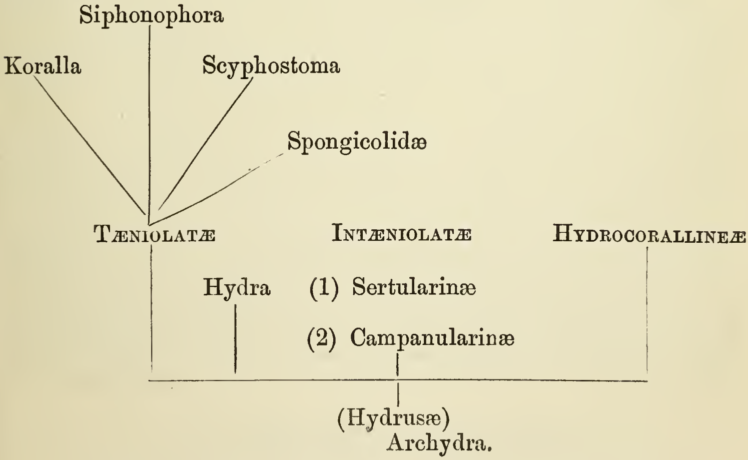
* Comptes Rendus, xcv. (1882) pp. 565–6.
† Jenaisch. Zeitschr. f. Naturwiss., xv. (1882) pp. 545–57 (2 pls.).

Organization of Hydroid Polyps.*—Dr. O. Hamann finds that in Hydroid Polyps there is rarely more than one—the longitudinal—axis; sometimes, however, the tentacles may be seen to be arranged along definite rays, so that the symmetrical arrangement of organs is not confined to the Medusæ; he shows that other genera besides *Tubularia* are provided with tæniolæ, and he uses the presence or absence of this character as an important aid to classification. In the Tæniolatæ he finds an endodermal musculature not only in the hypostome, to which it is confined in the Intæniolatæ, but also in the stomach.

True sensory cells or nerves were never detected in the ectoderm, and the structures which seemed to be such were found on closer examination to be merely interstitial cells. The endoderm of *Aglaophenia* was found to be filled with yellow cells, which appeared to be unicellular algæ taken in for the purposes of nutrition. The cells of the ectoderm were found to be (1) epithelio-muscular cells, (2) proper epithelial cells, (3) interstitial, deeper-lying cells, (4) true muscle cells, (5) interstitial cells converted into cnido-cells, and (6) glandular cells; after describing these the author passes to the supporting lamella, which is nothing more than a structureless thin sheet, which is secreted from the endoderm.

In dealing with the origin of the Medusæ, Dr. Hamann starts from a polyp-stock, any cells of which might become an egg-cell or a sperm-cell; imagining that separate persons might become broken off or separated from the colony, we can suppose that if they become adapted to the new conditions they would continue to reproduce their kind, but they would at the same time be modified by their new life, become, in fact, *Medusæ;* it will be seen that the complete homology of the Polyp and Medusa is here recognized. The planula is stated to be always formed by delamination or by the wandering of ectodermal cells.

The relations of various Cœlenterata are exhibited in the following table:—



* Jenaisch. Zeitschr. f. Naturwiss., xv. (1882) pp. 473–544 (6 pls.).

In the classification of the Hydroid Polyps the absence or presence of the tæniolæ gives us I. *Intæniolatæ* with the families *Hydrina*, *Campanularinæ*, and *Sertularinæ*, and II. *Tæniolatæ*, divisible into the *Acolloblastæ* (with fourteen families), where the supporting lamella takes no part in the formation of the tæniolæ, and the *Colloblastæ* (with the families *Spongicolidæ* and *Scyphostomidæ*) where the supporting lamella enters into the tæniolæ.

A study of the histiogenesis of the Hydroid Polyps shows that any histological element, whether of the ectoderm or of the endoderm, is capable of becoming converted into a generative, muscular, glandular, or other cell; the part of the endoderm which lines the hypostome is regarded as having a secretory function, while that found in the gastric cavity is thought to be digestive. It is important to note that the author has convinced himself that ovarian or sperm-cells are sometimes derived from the ectoderm and sometimes from the endoderm, in face of the definite statements made by some authorities.

Hydra.*—C. F. Jickeli, having been attracted by the view of Brandt that *Hydra grisea* is but a young stage of *H. viridis* in which the symbiotic *Zoochlorella* has not yet appeared, has addressed himself to the study of the differences between these species. He finds characteristic marks in the form of the urticating capsules, sufficiently striking to enable one to distinguish, from a small piece of well-preserved ectoderm, from which form the piece was taken. Further than this, *H. grisea* has in its endodermal cells bodies of a yellowish colour, which take the place of the green bodies of *H. viridis*, and, as these do not seem to have been detected by Brandt, the author believes that that naturalist had under observation not *H. grisea* but *H. vulgaris* (*fusca*), and this view is confirmed by the fact that while *H. vulgaris* may, in some stations, be quite common in spring, it is very rare in summer when *H. viridis* is abundant.

Vital Phenomena of Actiniæ.†—B. Solger finds that the Actiniæ have no free enzymotic digestive secretion; treatment of the mesenterial filaments with water dissolves out a tryptic enzyma in *Sagartia* and *Anthea* and a peptic one in *Cerianthus;* the yellow bodies (or zooxanthellæ of Brandt) which are found in the cells of the endoderm are probably, the author thinks, foreign algæ. Neither the cells of the mesoderm nor of the ectoderm are capable of digesting albuminoid bodies; when a so-called anal pore is present (as in *Cerianthus*) it does not serve for the evacuation of the fæcal masses, but for that of the generative products and the expulsion of water. As to their respiratory phenomena, we find that Actiniæ reduce oxyhæmoglobin, but, on the other hand, there are great differences exhibited by them in their power of resisting oxygen-starvation, *Sagartia troglodytes* living for a long time, *S. parasitica* dying soon. Some concluding observations are made on the results of recent researches into the chemical constitution of these cœlenterates.

* Zool. Anzeig., v. (1882) pp. 491–3.
† Biol. Centralbl., ii. (1882) pp. 399–404.

Ovaries of Actiniæ.*—R. Hertwig finds in *Corallimorphus rigidus* that the smallest ova form groups of 2–4 cells between the bases of the epithelial cells, and that the larger reach almost to the surface of the epithelium; an egg-cell taken in the act of passing outwards was seen to have part lying in the mesoderm and part in the endoderm; the two halves were separated by a constriction which was sufficiently deep to affect the form of the nucleus. Young egg-cells are connected with the epithelium by a short cord; when they leave this region their basal ends first pass into the mesoderm, and soon after the nucleus follows that portion. The filamentar apparatus of the egg-cell, which was only a temporary condition in this form, was more lasting in *Halcampa clavus*, a conical protoplasmic cord passing from the egg through the supporting lamella to the epithelium. Attention is directed to the peculiar form of the epithelial layer investing the egg, and to the curious fact that a similar phenomenon is to be observed in the Acraspedota, where the ova are likewise of endodermal origin.

Skeleton of Madrepores.†—The law of multiplication of the septa in hexaradiate corals, as first stated by Milne-Edwards and Haime, has gained a general if somewhat qualified acceptance. Schneider and Rötteken have proposed to modify it as regards the later and more puzzling stages of development. Semper seems to doubt the possibility of establishing the truth of any such formulæ, in the presence of the many and intricate variations which even the individuals of one species of coral may display. In his beautifully illustrated memoir on Astroides, Lacaze-Duthiers scarcely enters on the discussion of this question. We cannot cite any other zoologists who have made serious contributions to the subject.

G. v. Koch, however, who for years has studied the development and structure of the skeleton of the Anthozoa, now comes forward to introduce order where before there was chaos. Neither the law of Milne-Edwards nor that of Schneider are, in his opinion, supported by facts. Semper's scepticism has a certain justification, but must also be rejected. It may be accounted for as follows:—in one or more primary sectors the formation of new septa is liable to sustain a check; thus septa of the second cycle belonging to such a sector may resemble those of the third cycle elsewhere in the same coral, and so with other cycles. Or, otherwise expressed, a hurried or retarded development of certain septa may here and there occur. Our author's hypothesis, wherein he sums up the general result of his own investigations, is certainly very simple and intelligible:—Throughout the Hexacorallia, both Imporosa and Perforata, an approximately contemporaneous formation of septa takes place within all the chambers of the calyx, so that the septa of each added cycle are equal in number to all the previous septa. Exceptions must be referred to direct modification or to inherited changes in the growth of the whole animal.

* SB. Jenaisch. Gesell. Med. u. Naturwiss., 1881, pp. 18–20.
† Gegenbaur's Morph. Jahrbuch, viii. (1882) pp. 85–96 (1 pl.).

The attempts hitherto made to formulate the succession of the septa in the six-parted corals are at once shown in the annexed diagram, which we offer for the sake of comparison.

SCHNEIDER.	MILNE-EDWARDS.	KOCH.
1	1	1
3′	4	4
3	3	3
3′	5	4
2	2	2
3′	5	4
3	3	3
3′	4	4
1	1	1

Herr Koch has proceeded by examining, in their proper order, successive slices of single specimens, carefully selected, cleaned, and filled with black sealing-wax. A number of corals belonging to the same species were thus analyzed, one by one, and afterwards compared with each other. *Caryophyllia cyathus* was chosen as representing the Imporosa, *Dendrophyllia ramea* the Perforata.

The simultaneous appearance of the first six septa contrasts with the very peculiar succession of the primary mesenteries. Herr Koch regards this succession as due to modification.

In the second section of his present essay Herr Koch maintains that the theca of each corallite among the Anthozoa is formed by secondary coalescence from its septa, and not independently within the body-wall. Four Mediterranean corals, including the two species noted above, appeared to show that the theca really arises in this manner.

Studies on Gorgoniadæ.*—G. v. Koch associates under the name of *Alcyonaria axifera* those eight-rayed corals which possess an internal axis but which do not have it, like *Corallium*, formed of fused spicules, but developed from an axial epithelium; such forms are *Gorgonia*, *Gorgonella*, *Muricea*, *Pruinoa*, &c. After describing some new or old species the author passes to an account of the development of *G. verrucosa;* the rounded or oval egg is surrounded by a hyaline envelope and has a stalk-like process of attachment; both these are invested by a cylindrical epithelium derived from the endoderm. The testes are distinguished from the ovaries by their generally paler coloration; the young spermatozoa are at first rounded, but later on get long delicate tails; fertilization is always effected within the mother-polyp, and, it is possible, before the egg breaks away from its stalk. In the later stages of segmentation the outer cell-layer becomes converted into a layer of cylindrical epithelium (ectoderm); the nuclei of these are smaller than those of the cells within, and the author has been able to confirm his earlier statement that the spicules are developed in the cells of the ectoderm.

* MT. Zool. Stat. Neapel, iii. (1882) pp. 537–51.

Development of Alcyonaria.*—A. Kowalevsky and A. F. Marion have studied the development of two species of *Clavularia* and of *Sympodium coralloides;* they find that, as regards the segmentation of the ovum, which has never yet been completely observed in an Alcyonarian, the fecundated ovum of *C. crassa* remains for some time without dividing, and the ordinary histological reagents fail to demonstrate the presence of any nucleus, though, after segmentation, the nuclei are, notwithstanding their small size, easily recognizable. There would appear to be so rapid a division that no two-sphere stage is to be made out, six segments being the smallest number that can first be recognized. A peripheral and a central mass are easily separable from one another, and the former soon gives rise to a well-marked ectodermic layer; the endoderm is not slow in its appearance, and the store of yolk becomes rapidly used up. The larva having become fixed, its narrower end is depressed, and gives rise by invagination to an œsophageal sac, the bottom of which becomes pierced and forms a means of communication between the mesenteric cavity and the exterior. Meanwhile the ectoderm has become thickened by the formation of a layer of connective tissue, which may be regarded as the pseudo-mesoderm. Cells migrating from without give rise, in *Sympodium*, to small calcareous nuclei which become the sclerites; but in *Clavularia* the formation of the rudiments of these hard parts is delayed for some time.

Attention is also directed to the variations in the mode of development which are exhibited by *Sympodium*. While some larvæ undergo their changes rapidly, others retain their vermiform characters for a longer time, and in these there is no formation of sclerites, but the ectoderm is differentiated in the manner of *Clavularia;* at the base of the pseudo-mesoderm there is formed a fibrous layer which corresponds to an annular muscular band. A large number of primitive mesenteric septa are developed, and the whole of the endoderm is supplied with a layer of longitudinal muscular fibres; a transverse section of these larvæ is almost exactly comparable to that of an Actinian.

Porifera.

Manual of the Sponges.—The first volume of Bronn's 'Thierreich,' on the Amorphozoa, written by Bronn himself, was published in 1859. It included the Protozoa and the Sponges. Bütschli having undertaken the second edition of the Protozoa, of which the thirteenth Lieferung has appeared, a revised account of the Sponges is no less imperatively called for. Upon Dr. Vosmaer † has devolved this task. The first Lieferung of his 'Porifera' is now before us; its contents are bibliographical and historical, with four plates. A good epitome of the researches of Oscar Schmidt, Eilhard Schulze, and others, is certainly much needed by students, no complete general work on the Sponges having hitherto been issued.

* Comptes Rendus, xcv. (1882) pp. 562–5.

† 'Dr. H. G. Bronn's Klassen und Ordnungen des Thier-reichs. II. Band, Porifera. Neu bearbeitet von Dr. G. C. J. Vosmaer.' Winter, Leipzig und Heidelberg, 1882.

Development of Reniera filigrana.*—W. Marshall is led by his studies on this sponge to the conclusion that the Spongiæ represent a very old branch of the Cœlenterate stem, in which, in consequence of later adaptations and compressions, we have but a scanty phylogenetic history. Attention is directed to the view of Leuckart that the Porifera have a relation to the Cœlenterata in consequence of the homology of the ciliated cavity of the simple calcareous sponge (*Grantia*), with the body-cavity of a hydroid polyp, the mouth-orifices also correspond, and the pores of sponges are comparable to the water-spaces of the Cœlenterata. On the other hand, Balfour has insisted on the striking peculiarities of the sponge-larvæ, the early development of the mesoblast, and the remarkable characters of the digestive canals, as evidence in favour of the independent origin of the Poriferous phylum. To this Marshall answers that the larval peculiarities are chiefly to be seen in the Calcispongiæ, while the Fibrospongiæ have much more similarity to certain higher Cœlenterates (e. g. *Eucope*). The sessile condition of the sponges may be supposed to have conditioned the development of a skeleton, and this may be taken to be one of the causes of the marked development of the mesoderm. The entrance of the water-pores into the service of the digestive organs is looked upon as due to a change in function, which has again necessitated a greater development of the mesodermal tissues. It is next pointed out that in both groups we see a centrifugal canal system differentiated from the gastric cavity, which often breaks through the ectoderm and communicates with the exterior by permanent or inconstant pores; where there are tentacles present the canals or a part of them may be developed therein, and in some cases the pores opening from them to the exterior become so well developed that an astomatous condition is set up. In addition to this, the author believes that the ciliated investment of the tubes is derived from the endoderm layer. As to the absence of tentacles and stinging cells, attention is directed to the absence of both these organs from *Beroë*, and to the probability of their being nothing but the results of adaptation in the true Cœlenterata; while, further, their absence in sponges is to be explained by the present mode of nutrition exhibited by these forms.

Sponges and Cœlenterates are, then, Metazoa with gastric cavities and mesenterial pouches, with centrifugal canals arising from the former which may open to the exterior by pores and take in nutriment; they are invested by endodermal cells, which may become converted into flagellate cells. They are both developed from a common *Protactinian* stem-form.

New Fresh-water Sponges.—Mr. H. J. Carter describes † a new species of *Spongilla* from Bombay (*S. bombayensis*) of which only the statoblasts have been found. The most characteristic part of this species is, that the chitinous coat is spiculiferous, and that when the statoblast is divided through the middle or the outer layer crushed,

* Zeitschr. f. wiss. Zool., xxxvii. (1882) pp. 221–46 (2 pls.).
† Ann. and Mag. Nat. Hist., x. (1882) pp. 362–72 (1 pl.).

it also comes out divided or entire, as the case may be, when it may be mounted in Canada balsam. It then presents a damascened appearance, and becomes a very beautiful microscopical object, owing to the layer of spicules lying more or less parallel to each other, although in different directions, being immersed in the transparent light amber-coloured chitinous substance of which the coat is otherwise composed. The way in which the statoblast is firmly fixed to the stem of the herbaceous plant on which it was found, is also peculiar, inasmuch as the thick spiculiferous or external coat is continued on to the wood, thus forming a kind of neck or expanded base, which is so strongly attached as to bring away a portion of the wood when removed; while the "aperture," single or in plurality, varies in position on the *free* surface. They are for the most part more or less emptied of their germinal contents, and surrounded by a little sponge-structure, in which the skeleton spicules are found, one of which *being microspined*, at once distinguishes them from those of *S. alba* and *S. Carteri*, by whose statoblasts respectively and only they are frequently accompanied.

Mr. W. A. Haswell also describes * two new species of *Spongilla* (*S. sceptroides* and *S. botryoides*) from Brisbane, and *Meyenia Ramsayi* from New South Wales. Only one species of Australian fresh-water sponge has hitherto been described, being the one from Victoria, named by Bowerbank, *S. Capewelli*. Another species of *Meyenia* cannot yet be sufficiently determined from the few spicules found.

Protozoa.

Bütschli's Protozoa.—Nos. 10–13 of this part of Bronn's 'Thier-reich' have appeared, with plates XVII.–XL. The classification of the Heliozoa is completed, and the *Radiolaria* also, which have nearly 150 pages devoted to them; it is pointed out, in dealing with the "parasites" of the Radiolaria, that their nutrition and metabolism are really essentially aided by the presence of those guests which are of vegetable origin. An account is given of the deformed creature which Haeckel called *Thalassicola sanguinolenta*, and which has been modified by the taking of foreign bodies into its extra-capsular sarcode. It would seem to be certain that some of the group are phosphorescent, but the author is not so confident that a number of the forms said to dwell at the bottom of deep oceans really do so, as nothing in the structure of many of them seems to afford any support to the doctrine. Following Hertwig the group is divided into the *Peripylea* and *Monopylea*, according to the characters of the central capsule; while the third division is that of the *Phœodaria* or *Tripylea*, of which little is as yet known.

The concluding pages begin an account of the Sporozoa, and there the Gregarinidæ are chiefly dealt with.

New Ciliate Infusorian.†—Mr. F. W. Phillips describes a new genus and species under the name of *Calyptotricha pleuronemoides*, found attached to *Myriophyllum*. The animals are furnished with a

* Proc. Linn. Soc. N. S. Wales, vii. (1882) pp. 208–10.
† Journ. Linn. Soc. (Zool.) xvi. (1882) pp. 476–8 (1 fig.).

remarkable transparent hyaline ovate lorica, opening teat-like at both ends, and a vibratory membranous hood or velum almost equal to the ventral length. The anterior extremity of the body is protrusible from the lorica. Their length is ·001 inch, and the non-vibratile setose body-cilia are about two-thirds of this length, with shorter stronger vibratile cilia at the entrance of the velum.

Actinophrys sol.*—Dr. A. Gruber, dealing with the fusion of two or more individuals in the Heliozoa, says, that unfortunately the signification of this process is still obscure, and we are not in a position to establish an analogy with the accurately investigated conjugation in the Infusoria, since no alteration in the nuclei of the united individuals has ever been observed, nor any fusion of the nuclei. The difficulties of observation are enhanced by the fact that it is often impossible to see the nucleus in the living animal.

As Dr. Gruber had recently a somewhat rich collection of *Actinophrys sol* at his disposal, he tried, with the aid of Korschelt's staining process,† to arrive at some conclusion upon these points. He has not, however, yet succeeded so well as might be desired, and must, he says, defer any decision until further observations have been made. He has, however, become acquainted with some other peculiar facts which are of interest, and which he thinks it advisable in the first place to make known.

Two specimens of *Actinophrys sol* were observed, one well-formed, and another only about a third or fourth of its size; scarcely had the pseudopodia of the two touched than the smaller individual was quickly drawn to the larger, and united with it. After the union was complete, he fixed the animal and coloured it, when to his surprise only one nucleus was present. The experiment was repeated several times.

The first conclusion was that a union had taken place not only of the protoplasm, but also of the nuclei, but on fixing and colouring the objects *before* their union was completed, it was found that the small individuals did not contain any trace of a nucleus. Subsequent examination showed a large number of the small forms to be without any nucleus.

The rapidity with which the blending process takes place on the meeting of two individuals is remarkable: in from ten to fifteen minutes at the most, the small Heliozoa are absorbed by the large ones. It is the same when the *Actinophrys* does not take its fellow, but another organism, with this difference, however, that in that case the prey dies by contact with its enemy's pseudopodia, while the smaller individuals of the same species do not cease to show all the ordinary signs of life, indeed even an increased motion of the pseudopodia, and regular pulsation of the vacuoles. Once the author succeeded in bringing one after another three small ones to a larger one, and they were all fused in a very short time. During this process two flagellates were caught and devoured. Strangely

* Zool. Anzeig., v. (1882) pp. 423–6.
† Cf. this Journal, *ante*, p. 574.

enough a fourth, and to all appearance similar small individual, was, as often as it was brought near to the larger, rejected, even though entangled in the pseudopodia in a manner which, in previous instances, had "produced an attraction like that of magnetism."

In all the above cases this blending of a nucleated individual with one or more small non-nucleated ones can have no other significance than that of a simple increase of the substance of the large *Actinophrys*, which in the last instance, after the absorption of three individuals, had reached its highest point, so that the animal resisted any further accretion.

On the question of conjugation, and the phenomena of reproduction connected with it, these observations throw no light; but the fact is demonstrated, that the Protista, which as perfect cells possess a nucleus, are yet able to live without. It may be objected that the small individuals may originate through some pathological process, and not through the normal fission of the larger *Actinophrys*. This can hardly be the sole explanation, for, first, Dr. Gruber has himself observed such fission in the *Actinophrys*, and it occurs still more frequently in the Infusoria, where one animal divides into several dissimilar fragments; while, secondly, he has found it to be the same with the non-nucleated as well as with the small nucleated examples.

All this, however, does not prevent our seeing in the non-nucleated *Actinophrys* their general vital phenomena similar to that of a perfect individual, for they show the most active protoplasmic movements in their changing pseudopodia, and possess an excretion vacuole which pulsates as in the normal animal, and they are also in a position to take nourishment, and to digest it in another vacuole.

A difference between the nucleated and non-nucleated animals may lie in the fact that in the act of blending, the *rôle* of the smaller creature is simply passive, so that the conscious action (if the expression may be allowed) is only on the part of the normal individual. But even this failed in the following observation: An individual equal in size to a full-grown *Actinophrys*, which, however, raised the suspicion that it had no nucleus, was placed close to a small one, whereupon the same process of union occurred as before. The larger one, however, had no trace of a nucleus any more than the smaller, although it had behaved as a nucleated animal. This case shows also that the non-nucleated *Actinophrys* is capable of growing.

The author, therefore, draws the following conclusions from his observations:—The nucleus has no relation whatever to the part which movement, nutrition, excretion, and growth play in the surrounding protoplasm, nor to any of the physiological processes of the cell-body not directly connected with reproduction.

In the Monera, which possess no nuclei, this is easily understood, but with the higher Protozoa, which normally always possess them, we could hardly have expected to find their influence so wanting. Neither can the shape of these creatures which, contrary to the formless masses of the Monera, is more or less regular or constant, be imputed to the influence of the nucleus, since the non-nucleated *Actinophrys* maintain the normal form.

Nuclei of Lieberkuehnia.*—This fresh-water rhizopod was first described by Claparède and Lachmann, and afterwards by Cienkowski, under the new name of *Gromia paludosa*. The observations of these authors are, however, E. Maupas considers, far from being complete; and, moreover, are erroneous in some essential points.

The form of the body is variable, and may be perfectly spherical, ovoid, oblong, or even fusiform. Each individual can assume all these forms; and when the same specimen is under observation during several days, it is seen to pass through all these changes. These changes take place very slowly. The carapace is very transparent, and is closely applied to the surface of the body, and changes with it. It also shares in the fissiparous division. It cannot, therefore, be regarded as a true carapace, like that of the *Arcellæ* and the *Difflugiæ*, where the carapace is a product of chitinous secretion of the nature of a skeleton, and has a very different morphological value. In *Lieberkuehnia* the seeming carapace is in reality only an integument or ectosarc, which can be isolated by certain reagents from the endosarc.

The pseudopodia are capable of extending to a length of 2·26 mm., the body of the animal having a diameter of from 0·15 to 0·16 mm. The circulatory movement of the sarcode is one of the most rapid yet observed. The granules move through a space of 0·66 mm. a minute. The Infusoria which strike the meshes of their network are rendered motionless, and in this way *Lieberkuehnia* is able to capture large Infusoria, such as *Paramecium aurelia*. Sometimes the Infusoria are swallowed whole; sometimes the sarcode of the pseudopodia envelopes them on every side, and constitutes around them a digestive vacuole, in which they are dissolved outside of, and frequently at some distance from, the body. They do not reach this till later on, when they are already assimilated to the substance of the pseudopodia in whose circulatory movement they disappear. The digestion takes place, and is finished, entirely outside of the body. With small Infusoria, such as *Cyclidium glaucoma*, the operation hardly lasts five or six minutes; but *Paramecium aurelia* resists more than an hour. The sarcode of the mass of the body is in constant motion, not regularly in the same direction, like the cyclosis in *Paramecium aurelia*, but split up into currents with varying directions. This sarcode is hollowed out by numerous vacuoles of different volume and size, which are carried along by the currents, in which they are often seen to change their form, and sometimes to amalgamate one with another. They always end by coming to the periphery of the body, where they contract in a similar manner to that of the so-called contractile vacuoles. *Lieberkuehnia* is therefore not, as has been stated, destitute of these organs of excretion. It is, on the contrary, perhaps more richly furnished with them than many other Protozoa. There is simply this difference, that the contractile vacuoles are neither permanent nor localized in any region of the body, every part of which may serve as a basis for their formation.

* Comptes Rendus, xcv. (1882) pp. 191–4. Ann. and Mag. Nat. Hist., x. (1882) pp. 410–13.

Contrary also to what has been asserted, *Lieberkuehnia* likewise possesses a great number of *nuclei*, spherical, and measuring 4 μ. It also increases by transverse division, as described by Cienkowski, but M. Maupas has seen individuals divide not only into two but into three. The body lengthened out into a long spindle, which, after the formation of two new peduncles bearing pseudopodia, became constricted at two points, and was thus divided into three nearly equal segments. One specimen, resulting from one of these divisions into three, developed, as soon as it was detached, a second peduncle bearing pseudopodia, situated at the opposite extremity to the one it already possessed. It continued thus to live with two places of emission of largely expanded pseudopodia. It was observed in this state for more than a day without any further changes taking place than those slow ones in the form of the body above-mentioned. In this, therefore, there was no preparation for a further fissiparous division, and the *Lieberkuehnia*, so constituted, with its two places of emission of pseudopodia situated at the two opposite extremities, would answer to the morphological type which has served to establish the family of the Amphistomina. It may be considered, therefore, one of those intermediate forms which connect separated families.

Parasitic Protozoa.*—J. Kunstler describes five new parasitic Protozoa found by him.

The first is a flagellate living in the intestine of the larva of *Melolontha vulgaris*, having a body which is elongated, flattened, rounded anteriorly and pointed posteriorly, and seems covered with longitudinal ribs more or less anastomosed; it is often depressed at the sides, so as to have two lateral wings. At its anterior extremity are inserted six long striated flagella which give it a jerking movement. In well-developed individuals other filaments (sometimes fifteen in number) are frequently seen in the shape of a narrow spear-head, very much elongated and a little distorted, which are attached to the most diverse parts of the body, and are agitated with a continual quivering movement. Near to the point of insertion of the flagella there is a buccal aperture which is connected, by means of a short and narrow canal, with a clear oval space occupying the central region of the body, which seems to be a digestive cavity. On the right of this region there is often found a sort of vesicle whose appearance recalls that of a contractile vesicle.

Another flagellate is frequently found with the preceding one, somewhat similar to it; but its body, which is not ribbed, is more globular and shorter, and it has only four flagella.

The larva of *Oryctes nasicornis* is also the habitation of an organism smaller and more delicate than the preceding; it dies and disappears very quickly in preparations. Only two flagella were seen.

The intestine of the tadpole is often inhabited by a flagellate, which differs considerably from *Trichomonas batrachorum* Perty. It has six superior flagella, and a lower trailing filament; it has a rather

* Comptes Rendus, xcv. (1882) pp. 347–9.

long tail, of striated muscular structure, larger than the flagella, and sometimes even double; its form is somewhat variable, and it is destitute of the ridge and serrated crest which is seen in *Trichomonas.*

In this same intestine was found a remarkable organism, *Giardia agilis*, which the author thinks ought to occupy an intermediate place between "certain Schizomycetes, such as *Vibrio*, *Spirillum*, and the Monads." The body is formed of two clearly distinct portions: the upper and larger one has large vacuoles; the lower is much narrower, thicker, almost filiform, and resembling the large body of a *Vibrio;* but its length is much greater, and it terminates in a fine point. Between these two regions there is a slight constriction. From the lower circumference of the former portion long flagella proceed in a downward direction, which often remain attached to the narrow portion for varying distances; two other flagella are inserted at the inferior free extremity. The narrow portion is very mobile and very flexible; it constitutes a locomotive organ of very great power, and consequently the organism moves with remarkable activity. This kind of tail has an undulatory movement, similar to that of the tail of a tadpole, but at the same time it has a movement of "circumduction," and the combination of these two movements gives to it a helicoidal motion of remarkable vivacity.

Intestinal Parasites of Oysters.*—A. Certes has found, in the oyster, *Hexamita inflata*, which is also found in the brackish waters of the region he studied; in addition to forms which presented two posterior filaments there were some observed that had four, and these are regarded as individuals undergoing longitudinal fission. The most interesting parasite was a new species of *Trypanosoma* — *T. balbianii*, which has at first sight the appearance of a large *Spirillum*. The action of the vapour of osmic acid, or iodized serum, and methyl-blue reveals the presence of a membrane, which is not rigid, but which appears to be contractile, and to obey the will of the animal; no mouth, anus, or contractile vacuole were to be detected in the interior, nor is there any nucleus or nucleolus; so that it is a Moneron with an undulating membrane.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Structure and Movement of Protoplasm.†—G. Klebs gives a useful summary of the present state of our knowledge respecting the structure of protoplasm and the movements to which it is subject, and the connection between these two. He sums up by saying that, while we are still ignorant of the chemical composition of protoplasm, and of the mechanical forces which lie at the base of its mobility, it becomes

* Comptes Rendus, xcv. (1882) pp. 463–5.
† Biol. Centralbl., i. (1881) pp. 577–94.

more and more evident that the life of all living organisms depends on the vitality of this one and the same substance.

Protoplasm of Compound Laticiferous Tubes.*—The presence of protoplasm in laticiferous vessels was not detected by the older botanists; it has, however, been recognized in the compound laticiferous tubes of the Euphorbiaceæ, Urticaceæ, Apocynaceæ, and Asclepiadeæ. E. Schmidt now adds to this list the following orders:—In the Cichoriaceæ, protoplasmic sac and nuclei were detected in *Scorzonera hispanica* and species of *Sonchus;* in Campanulaceæ, in *Campanula ramosissima;* in Lobeliaceæ, in *Siphocampylos bicolor;* and in Papaveraceæ, in *Papaver*. In *Chelidonium* the coalescence of the individual cells is imperfect; and the protoplasmic sac and nucleus could be made out in each separate cell. The same is the case with *Carica Papaya* among Papayaceæ. In *Caladium marmoratum*, among Aroideæ, similar results were obtained. The so-called laticiferous tubes of Musaceæ are regarded by the author as rows of superposed tubes the contents of which are only locally in communication with one another; no nucleus or living protoplasmic sac could be detected in them. In many cases, and especially in the Musaceæ, it is very easy to mistake the coagulated latex for true protoplasm.

In all the plants observed which contained compound laticiferous tubes, the protoplasm of the individual cells coalesces into a large "symplast," which retains its optical and colouring properties to the last without change. The nuclei also remain in the vessels after the fusion of the cells without any alteration of form or structure till the complete maturity of the organ. It is not probable that any division of the nuclei takes place after the fusion. The vitality of the protoplasmic sac appears to be established by the following facts. In many cases the fusion takes place before the organ has attained its full size. If the mature vessels are injured, the protoplasm has also the power of repairing the wound, as in the multinucleated Siphoneæ, and in many pollen-tubes. This is effected by annular thickening ridges on the wall of the tube, which finally completely close up the wound, the substance of these thickenings being identical with that of the callus of sieve-tubes. An additional proof of the vitality of the protoplasm is that, after the growth of the wall of the vessel is completed, it increases in thickness over its whole surface; and further, in the living plant, the latex cannot be coagulated by contact with water of imbibition. The latex, which is formed subsequently to the fusion, can also be regarded only as the product of a living protoplasm in the laticiferous vessels.

Development of the Embryo-sac.†—As a sequel to his researches on the embryo-sac of Leguminosæ,‡ L. Guignard gives an historical *résumé* of our knowledge of the structure of this organ in various natural families of plants, derived from his own observations and those of others. The following is an epitome of the general results:—

The embryo-sac never arises from the fusion of two cells, but

* Bot. Ztg., xl. (1882) pp. 435–48, 451–66 (1 pl.).
† Ann. Sci. Nat. (Bot.) xiii. (1882) pp. 136–99 (5 pls.).
‡ See this Journal, *ante*, p. 644.

always from the increase in size of one only. While this cell is usually the lower daughter-cell among those which arise from the mother-cell, it may be any one of the others, thus establishing a certain equivalence among them. In the latter case only are there one or more anticlinals. Sometimes the axile hypodermal cell of the nucellus divides, giving rise immediately, in contact with the epidermis, to an apical cell, or initial cell of the calotte, and below to a subapical cell or mother-cell of the embryo-sac; sometimes it is itself the mother-cell of the embryo-sac. Both these forms occur among monocotyledons and apopetalous dicotyledons, but among gamopetalous dicotyledons the former only has been met with.

Among monocotyledons the mother-cell either remains undivided, or divides into a variable number of daughter-cells; in the former case it developes directly into the embryo-sac. Among apopetalous dicotyledons several mother-cells may develope, and in some cases this phenomenon seems to be constant; but ultimately there is never more than one embryo-sac. The mother-cell gives birth either to three daughter-cells in basipetal order, or to four secondary ones formed by bipartition of the primary daughter-cells, or even to a large number. Among gamopetalous dicotyledons the formation of four secondary daughter-cells seems to be normal.

In the greater part of angiosperms the mother-cell of the embryo-sac is the lower daughter-cell; but there are exceptions to this rule. The tendency of the other daughter-cells to develope into the embryo-sac is manifested by the frequent development of two adjacent cells, the nuclei of which divide like that of the mother-cell of the embryo-sac. The walls of the daughter-cells are often thick, refringent, and present some analogy to those of the anther.

The number of cells of the female apparatus and of antipodal cells is remarkably constant, apart from well-known exceptions, as *Santalum*, *Gomphrena*, and *Loranthus;* but their form and disposition are very variable. Among monocotyledons the synergidæ occupy the summit of the embryo-sac; they are usually ovoid, and provided with a vacuole. The oosphere is inserted either at the same level at the summit, or lower down laterally. The antipodals often remain very small, or sometimes become almost as large as the sexual cells; occasionally they even divide. The fusion of the polar nuclei often takes place towards the centre of the embryo-sac, rarely in its upper part. Among apopetalæ the synergidæ are situated at the summit, and are rarely without a vacuole when mature. The oosphere is distinguished by its nucleus, situated at the base; it is inserted laterally, and generally descends much lower than the two synergidæ. The antipodals are sometimes small, sometimes large. The fusion of the polar nuclei takes place towards the centre or towards the apex. Among gamopetalæ the synergidæ, placed on each side of the plane of symmetry, have a characteristic form; in the majority of cases they are elongated, and contract to a point at the summit; they have a large vacuole. The oosphere is always inserted laterally, and its nucleus is larger than that of the synergidæ. The antipodals are rarely

placed at the same level; more often they are superposed; sometimes they multiply, and form a tissue of a special nature. The fusion of the polar nuclei takes place towards the centre of the sac, or higher up, near the oosphere.

The author then traces the genetic history of the embryo-sac of angiosperms through the various classes of the higher cryptogams, and finally through the gymnosperms. The pollen-grain of gymnosperms, in which Strasburger has demonstrated the existence of a single partition, presents a close analogy to the microspore of *Selaginella*. One of the two cells developes into the pollen-tube, and represents an antheridium; the other is equivalent to a rudimentary male prothallium. The naked cells, observed by Hofmeister and Strasburger at the extremity of the pollen-tube, may be compared to the mother-cells of antherozoids, and complete the analogy, which is rendered more evident by comparing the mode of formation of the microspores of vascular cryptogams with that of the pollen-grains of gymnosperms. The researches of Strasburger and Elfving have shown the existence of a similar division-wall in the pollen-grain of angiosperms. Two cells are thus formed; one of these, the vegetative cell, further divides into a prothallium of two or three cells; the other, the nucleus of which has not been observed to divide, except in the Cycadeæ, becomes the pollen-tube; the nucleus, situated at the extremity of the tube, appears to play an important part in the process of fecundation.

As regards the homology of the female organs, the author contends that the facts support Strasburger's theory that the embryo-sac is the homologue of the macrospore of the higher cryptogams, and not the nucellus, as Warming maintains, a view which is inconsistent with the remarkable phenomenon of the fusion of the polar nuclei. The female prothallium is represented in gymnosperms by the endosperm, in angiosperms by the antipodals and the two polar nuclei; the synergidæ are endosperm-cells endowed with a special function; and the endosperm of angiosperms, which is formed only after fecundation, by division of the secondary nucleus of the embryo-sac, is the result of the resumption of an interrupted development.

Development of the Embryo in Lupinus.*—An apparent anomaly in the embryogeny of certain species of *Lupinus* is explained by L. Guignard as due to differences in the structure of the ovule. The species of the genus may be divided into two groups, according to the number of ovular integuments; one group, represented by *L. polyphyllus*, having only one integument; the other, represented by *L. luteus*, having two; and this is correlated with a difference in the structure and development of the suspensor or proembryo. The number of pairs of cells of which the suspensor is composed, and consequently the length of this organ, varies with the species; but in all those which have only one integument, it finally becomes disintegrated, and the cells which constituted it arrange themselves on the median line from the micropyle to the embryo, which is always

* Bull. Soc. Bot. France, xviii. (1881) pp. 231–5. See this Journal, *ante*, p. 644.

situated at the base of the cavity, at about equal distances from the chalaza and the micropyle. These disintegrated proembryonic cells were taken by Hegelmaier for a special organ, peculiar to *Lupinus*, formed before fertilization. In the species with two integuments this phenomenon is not presented, owing to the permanent coherence of the cells of which the suspensor is composed.

Homology of the Ovule.*—F. Pax describes in detail instances of phyllody of the carpels in *Aquilegia vulgaris* and *formosa*, with especial reference to the genetic morphology of the ovule. He comes to the same conclusion as Brongniart and Celakovsky,† that the two integuments of the ovule together constitute a leaflet, on the upper side of which the nucellus is equivalent to a metablast. The identity of this leaflet with a pinnule of a fertile fern-frond is evident; and the homologies of the parts may be expressed as follows:—

Fern.	*Ovule.*
Spore.	
Macrospore.	Embryo-sac.
Macrosporangium.	Nucellus.
Sorus.	Several nucelli.
Pinnule.	Ovular leaflet.

Reproductive Organs of Cycadeæ.‡—An examination of the reproductive organs of several species of Cycadeæ leads M. Treub to the following general conclusions:—

Each scale of the female cone (in *Ceratozamia longifolia*) bears two sporangiferous lobes, each of which gives birth to a macrosporangium. The macrosporangium can be detected in the interior of the lobe before any external differentiation is perceptible. In each macrosporangium can be recognized, at a later period, the three following parts:—(1) the reproductive or primordial cells; (2) in the interior an external parietal layer; and (3) an internal compound parietal layer. There is, in *Ceratozamia*, only a single macrospore mother-cell; and this does not divide, as in cryptogams; it produces the single macrospore, in the same way as the embryo-sac is in general formed. Shortly after the first appearance of the macrosporangium within the sporangiferous lobe, this latter produces, on its apex, turned towards the axis of the cone, two new formations, the nucellus and the integument. The nucellus owes its origin to one or two hypodermal layers of the macrosporangium; the integument is elevated on the lobe around the nucellus.

With regard to the homology of the parts—if *Ceratozamia* is to be taken as a normal type of the Cycadeæ, as seems most probable—the macrosporangium of Cycadeæ, developed within the sporangiferous lobe, is perfectly homologous to a sporangium of *Ophioglossum;* the nucellus and the integuments are new formations which find no homologue in cryptogams. In the Cycadeæ, therefore, neither the nucellus nor the ovule represents a sporangium; the sporangiferous

* 'Flora,' lxv. (1882) pp. 306–16 (1 pl.).
† See this Journal, *ante*, p. 648.
‡ Ann. Sci. Nat. (Bot.) xii. (1882) pp. 212–32 (7 pls.).

lobes must rather be compared to the "ovular mamelon" in angiosperms. The sporangiferous lobe, bearing the nucellus and the integuments, may be regarded as presenting the transition from the sporangium of *Ophioglossum* to the ovule of angiosperms.

Although the Cycadeæ are undoubtedly the most ancient phanerogams, and the most nearly allied to cryptogams, M. Treub does not consider it probable that any existing gymnosperms represent the actual transition from cryptogams to angiosperms; the forms we now have are probably derived from those which actually constituted the connecting link.

Cell- and Nuclear Division in the Formation of the Pollen of Hemerocallis fulva.*—According to E. Tangl, the young pollen mother-cells of *Hemerocallis fulva* have comparatively large finely granular nuclei, containing several nucleoli which are distinctly coloured by methyl-green or Beale's carmine. At a later period the number of nucleoli diminishes, so that each nucleus has only one or less often two, which are no longer coloured by methyl-green, while their colouring by Beale's carmine remains unchanged. At the same time the originally regular distribution of the granules is altered. They at first form a network, and afterwards a thin layer on the wall of the nucleus, with a larger central group, and an anastomosing network between them. To the hyaline substance between the granules Tangl applies Flemming's term, "intermediate substance." At this stage the structure of the nucleus is completely destroyed by alcohol; by treatment with acetic acid and methyl-green the granules are coloured a dark blue-green. At a later period the regularly distributed small granules of the nucleus are replaced by larger granular structures which behave in the same way towards reagents. Subsequently the nuclear membrane disappears, and the intermediate substance assumes a granular character, exactly resembling that of the surrounding protoplasm. This is followed by a new nucleus of irregular outline, destitute of membrane, and nearly entirely composed of granular substance which takes the pigment, and which is probably derived genetically from a coalescence of the granular structures with the nucleolus of the earlier nucleus. If two nucleoli are originally present, one of them appears not to take part in this coalescence, but to remain imbedded in the protoplasm. From the new nucleus is formed the nuclear plate, consisting in most cases of granules somewhat elongated in the direction of the axis of the spindle, less often of a continuous disk with teeth directed towards the pole, and lying in a clear hyaline portion of the protoplasm. The daughter-nuclei are at first roundish and finely granular; they subsequently change their form from unequal growth, their contents becoming at the same time differentiated into granules, intermediate substance, and membrane. The granules afterwards all lie on the membrane, on which they form a network with polygonal meshes. The formation of the nuclear plates in the secondary nuclei is preceded by a considerable diminu-

* Denkschr. K.K. Akad. Wiss. (Wien), xlv. (1882) 22 pp. (4 pls.). See Bot. Centralbl., xi. (1882) p. 169.

tion of the intermediate substance and of the entire volume of the nucleus. The cell-plates are formed in the same way as in other pollen-grains; but the arrangement of the daughter-nuclei differs somewhat from the normal, since they lie either in a plane or cross-wise. The special mother-cells sometimes undergo subsequent divisions, resulting in the formation of smaller pollen-grains.

Comparing this development with that of the animal ovum, the author considers the small globular structures or nucleoli, which often accompany the primary nucleus of the mother-cells when reduced by retrogressive metamorphosis, to be the homologue of the elements of the germinal vesicle which are not active in the formation of the bi-aster.

Structure and Growth of the Cell-wall.*—Professor E. Strasburger's most recent publication is divided into the following sections:—The origin and growth in thickness of the cell-wall; the growth of starch-grains; the relationship of swelling to anatomical structure; the formation of membrane in the animal kingdom; the double refraction of organized structures; the molecular structure of organized bodies; the assimilation of carbon; the function of the cell-nucleus; the permeability of the cell-wall; and the behaviour of the cell-nucleus in the process of sexual reproduction. The following are some of the more important results at which he has arrived:—

With regard to the intimate structure of organized bodies, Prof. Strasburger entirely dissents from Naegeli's micellar hypothesis. This hypothesis was based upon the phenomena of "swelling-up" which are so characteristic of organized bodies, and upon the optical properties which certain of these bodies possess. Professor Strasburger points out that swelling-up may be as well ascribed to the taking-up of water between the molecules of the body as to its being taken up between Naegeli's micellæ. He shows also that the double refraction of organized bodies, such as cell-walls and starch-grains, depends upon their organization as a whole; for when once their organization is destroyed, their double refraction is lost, a result which cannot be explained on the micellar theory, since the particles of the disintegrated micellæ would, like particles of broken crystals, still retain their power of double refraction. According to Strasburger the molecules of an organized body are not aggregated into micellæ which are held together by attraction, but are linked together, probably by means of multivalent atoms, by chemical affinity, in a reticulate manner. Swelling-up is then the expression of the taking-up of water into the meshes of the molecular reticulum, where it is retained by intermolecular capillarity. The more extensible the reticulum, that is, the more mobile the groups of molecules within their position of equilibrium, the greater the amount of swelling-up. The limit is reached when the chemical affinity of the molecules and the force of the intermolecular capillarity are equal; if the latter

* Strasburger, E., 'Ueber den Bau u. das Wachsthum der Zellhäute.' 264 pp. (8 pls.) Jena, 1882. Cf. also article by Dr. S. H. Vines in 'Nature,' xxvi. (1882) p. 595, and Bot. Centralbl., xi. (1882) pp. 269–83.

exceed the former at any moment, the result is the destruction of the molecular reticulum, or, in other words, of the organization. Protoplasm differs from other organized bodies in that the grouping of its molecules is undergoing perpetual change, the result of this molecular activity being the phenomena which we term vital.

The growth in thickness of cell-walls and of starch-grains takes place, according to Professor Strasburger, by the deposition of successive layers; in opposition to Naegeli's view, that the mode of growth was intussusceptive, with subsequent differentiation of layers. Even the surface-growth of cell-walls is not, in his opinion, intussusceptive, but is merely due to stretching.

With reference to the mode of formation of the cell-wall and of the thickening-layers, Strasburger agrees with the view of Schmitz that the cell-wall is formed by the actual conversion of a layer of the protoplasm, that is, chemically speaking, by the production of a layer of cellulose from a layer of proteid. When a mass of protoplasm is about to clothe itself with a membrane, the peripheral layer becomes densely filled with minute proteid bodies, the microsomata, and this layer then becomes converted into cellulose. The wall of a young wood-cell of *Pinus*, for instance, is clothed internally with a layer of protoplasm filled with microsomata, which are arranged in spiral rows; the microsomata then gradually disappear, and the layer of protoplasm is found to be replaced by a layer of cellulose, which presents spiral striation corresponding to the previously existing rows of microsomata, and which constitutes a thickening layer of the cell-wall. In cells the walls of which become much thickened, the whole of the protoplasm may be gradually used up in this way. Again, the wall of pollen-grains and of spores is formed from a peripheral layer of the protoplasm which contains abundant microsomata. Its subsequent growth, and especially the development of the asperities which it commonly presents, is effected by the surrounding protoplasm which is derived from the disorganized tapetal cells; this is especially well shown in the development of the epispore of *Equisetum* and of *Marsilia*. When an intine or endospore is present, it is produced like the outer coat from a peripheral layer of the protoplasm of the pollen-grain or spore. Further, the septum which is formed in the division of a cell is produced in the same way. The cell-plate, like the peripheral layer of the protoplasm of a young pollen-grain, contains microsomata which disappear, and it is then converted into a plate of cellulose. Finally, the successive layers of a starch-grain are produced by the alteration into starch of layers of proteid-substance derived from the starch-forming corpuscle (amyloplast).

Professor Strasburger next points out that the starch which makes its appearance in the chlorophyll-corpuscles under the influence of light, is derived from the proteid of the corpuscles by dissociation. The formation of this starch is therefore not the immediate product of the synthetic processes going on in the chlorophyll-corpuscles, but only a secondary product. The processes in question produce proteid. Professor Strasburger is inclined to accept Erlenmeyer's hypothesis, that methyl aldehyd is formed in the chlorophyll-corpuscles from

carbon dioxide and water, and to believe that by polymerization a substance is produced which can combine with the nitrogenous residues of previous dissociations of proteid to reconstitute proteid. He does not agree with the suggestion of Loew and Bokorny that the methyl aldehyd may combine with ammonia and sulphur to form proteid *de novo*.

Lastly, Professor Strasburger makes a suggestion as to the probable physiological significance of the nucleus. He points out that the nucleus cannot be regarded as regulating cell-division; for instances are known of cell-division taking place without previous nuclear division, and, conversely, of nuclear division taking place without cell-division. He is of opinion that the nucleus plays an important part in the formation of proteid in the cell. This view is founded upon the facts that one or more nuclei have been found to be present in the vast majority of plant-cells, that the nucleus is, as a general rule, the most persistent protoplasmic structure, and that it gives the various proteid reactions in a very marked manner.

Order of Appearance of the Primary Vessels in Aerial Organs.* —A. Trécul has collected the results of a long series of observations on the formation of the first vessels in the stem, leaves, and floral organs of the following plants:—*Anagallis arvensis*, *Primula elatior*, *officinalis*, *grandiflora*, and other species, *Lysimachia*, *Ruta*, *Lupinus*, *Astragalus*, *Galega officinalis*, *Fœniculum vulgare* and *dulce*, *Iris*, *Allium*, *Funkia*, *Hemerocallis*, and a number of grasses. For the details of the observations reference must be made to the paper itself. Among the more important of the general results, M. Trécul is led to contest the usual statement that all stems and leaves branch from below upwards, and especially Sachs' explanation of the pinnate and other forms of division in leaves as referable to a scorpioid type. The order of appearance of the vascular bundles shows, on the contrary, that there are two kinds of pinnate leaves, basifugal or acropetal, and basipetal; and the same is true of leaves where the segmentation is not carried so far; and also of the secondary divisions of the leaflets themselves. The basipetal development may also be altogether independent of any scorpioid arrangement.

Collenchyma.†—An examination of the structure and mode of formation of collenchyma in a large number of plants, made by C. van Wisselingh, confirms the general statement of Sachs, that this tissue has its origin directly in the fundamental tissue. In all the plants examined by him the vascular bundles were already in existence in the procambial condition before the formation of the collenchyma. He found no instance of the common origin of collenchyma and mestome described by Haberlandt and Ambronn. The number of layers of cells found in the youngest state between the epidermis and vascular bundles varied from two to six, or even more.

Most commonly, in the tissue intermediate between the epidermis

* Ann. Sci. Nat. (Bot.) xii. (1882) pp. 251–381.

† Arch. Néerland. Sci., xvii. (1882) pp. 23–58 (2 pls.). Cf. this Journal, i. (1881) p. 768.

and vascular bundles, cell-division plays, in the first place, the most important part, and afterwards the collenchymatous thickening; more rarely the two processes are simultaneous. The period when the thickening begins to manifest itself prominently depends on the mechanical function which the collenchyma has to fulfil in the young organs of the plant.

It is not uncommon for the thickening of the cell-walls to be accompanied by rounding off and disappearance of the intercellular spaces. The septated collenchymatous fibres, which terminate at the extremity of the stem in *Lamium purpureum* and *Aesculus japonica* proceed from parenchymatous cells. Haberlandt found, on the contrary, that in *Lamium purpureum*, *Atherurus ternatus*, *Cucurbita Pepo*, and *Tradescantia erecta*, the fibres originate from a generating prosenchymatous tissue formed by repeated longitudinal division of merismatic mother-cells. In *Chenopodium album* the same observer always found collenchyma originating from parenchyma.

In none of the plants examined was the author able to detect a closer genetic connection between the cells of the collenchyma themselves than between them and the adjacent parenchymatous cells. Sanio, on the contrary, states, in the case of *Euonymus latifolius* and *Peperomia blanda*, and Haberlandt in that of *Tradescantia erecta*, that the collenchyma is derived from a single hypodermal layer of cells.

Stomata in a Fossil Plant.*—In a large series of fossil plants obtained from the Turonian beds of the cretaceous formation from the neighbourhood of Bagnois (Gard) R. Zeiller finds very well-preserved wood of a conifer closely allied to the *Thuyites Hoheneggeri* Ettings. of the Wealden. In the ultimate branches or leaves, the stomata may be exceedingly well made out; and they are remarkable for having, instead of a single fissure, an opening in the form of a star with four or five rays. The stomata are formed of four, or less often of five cells arranged in a rosette, the walls of which radiate towards a central point, but leaving an orifice in the centre, in length about one-third or two-fifths of the rays. The mechanism by which the opening is produced is the same as in ordinary stomata, except that four or five cells instead of two share in it. The stomatic orifice occupies the bottom of a slight depression, though not so well marked as in the allied recent *Callitris quadrivalvis*, *Libocedrus decurrens*, and *Frenela*, and are usually surrounded, as in them, by a slightly projecting margin of cuticle. The stomata are arranged regularly in rows over the whole surface of the leaf.

Spiral Cells in Crinum and Nepenthes.†—A. Trécul and L. Mangin both describe, as the result of separate investigations, the large spiral cells found by the first in several species of *Crinum*, by the last also in *Nepenthes phyllamphora*. In *Crinum americanum* they are dispersed through all parts of the parenchymatous tissue of both faces of the leaf, into the immediate neighbourhood of the large inter-

* Bull. Soc. Bot. France, xxviii. (1881) pp. 210–4.

† Ann. Sci. Nat. (Bot.) xiii. (1882) pp. 200–7 and 208–16 (1 pl.).

cellular spaces, and of the fibro-vascular bundles, usually collected together into groups, often in long longitudinal bundles. They are greatly elongated cells, from 0·5 to even 13 mm. in length, and from 0·025 to 0·06 mm. in diameter, and occasionally are even branched. They contain nothing but air, and are surrounded by ordinary parenchymatous cells. Their form and disposition differ in other species of *Crinum*, but are nearly uniform in the same species. They were not found by M. Trécul in any part of the plant except the leaves; but M. Mangin finds them also in the cortical tissue of the stem, where they attain a still greater size. M. Mangin considers them as analogous to internal hairs.

In *Nepenthes phyllamphora* similar cells occur in the stem, the leaves, and the pitchers, but always isolated. The parenchyma which contains them is here compact, and not furnished with intercellular passages.

Structure of Secretory Glands.*—An examination of the internal glands in a large number of plants has led Dr. F. R. v. Höhnel to the following general results:—

The glands of the Myrtaceæ, those Leguminosæ which were examined (*Amorpha*, *Hymenea*, and *Trachylobium*), the Hypericineæ (*Hypericum* and *Androsæmum*), and of *Oxalis*, *Lysimachia*, *Myrsine*, *Ardisia*, and *Peganum Harmala* are schizogenous; while (except *Peganum Harmala*) those of the Rutaceæ and their allies (*Callionema*, *Citrus*, *Toddalia*, *Boronia*, *Correa*, and *Ptelea*) are lysigenous.

The secretion-cavity is always completely closed in lysigenous glands: while in schizogenous glands there are three distinct varieties:—(1) completely closed, which is the ordinary case; (2) those which at length burst from the copious excretion of fluid (*Oxalis floribunda*); and (3) altogether open; these are properly only secretory portions of ordinary air-containing intercellular spaces (*Peganum Harmala* and *Lysimachia ephemera*).

Glands which are buried in the tissue are either entirely dermatogenous (*Amorpha*, and those Myrtaceæ where the glands are immediately beneath the epidermis), or are in their outer portion formed out of the epidermis (*Citrus*, *Dictamnus*, and probably *Correa*, *Toddalia*, and many other genera of Rutaceæ), or their origin is altogether independent of the epidermis (all deeply buried glands, as those of *Eucalyptus*, *Hypericum*, *Ardisia*, *Myrsine*, &c.). Lysigenous glands appear to be generally formed from several cells which have become separated before the first appearance of the gland (*Callionema* and *Citrus*); while schizogenous glands are almost always formed from a single cell (Myrtaceæ, *Lysimachia*, *Hypericum*, and *Myrsine*), very seldom from several (*Amorpha*).

When mature the distinction between schizogenous and lysigenous glands is always observable. The former always have an epithelium sharply defined on the inside, and usually more or less clearly distinguishable from the surrounding cellular tissue by the nature of the cell-wall and of the cell-contents; it is from this that the fluid

* SB. K.K. Akad. Wiss. (Wien), lxxxiv. (1881) pp. 565–603 (6 pls.).

is excreted, and it is entirely wanting in lysigenous glands; the latter are usually surrounded by partially absorbed cells which are not sharply distinguishable from the surrounding tissue.

In glands which originate from the epidermis (*Amorpha*, *Myrtus*, and *Eugenia*), it is not uncommon that instead of growing into the parenchyma, they become glandular, warty, or conical trichomes; which appears to indicate that internal epidermal glands originate as trichomic glands; the latter being phylogenetically the older.

The schizogenous glands of *Hymenea* and *Trachylobium* contain copal; the hard copal of *Trachylobium* having undoubtedly a similar origin. In *Ardisia crenulata* are peculiar schizogenous secretory organs, formed locally out of the medulla of the veins of the margin of the leaf, and which contain an albuminoid substance; of these a careful examination was made. The same species also possesses secretory organs, which from their origin and structure must be regarded as a coalescence of secretory tubes.

The mucilage-tubes of *Abies* possess albuminoid crystalloids in the interior of the mass of mucilage formed in the protoplasm. A description is given also of the origin, structure of the wall, and nature of the contents of the secretory tubes of *Evodia glauca*, *Rhamnus*, *Æonium tortuosum*, *Mesembryanthemum*, *Physostegia virginiana*, *Calycanthus*, *Cæsalpinia echinata*, &c. Oil and mucilage-tubes also occur in the wood of some Laurineæ.

Sphero-crystals.*—G. Kraus records the discovery of sphero-crystals in *Ptelea trifoliata*, *Conium maculatum*, and *Æthusa*, apparently identical in composition with those previously detected in *Cocculus laurifolius*. In *Ptelea* they occur in the leaf only; in *Conium* also in the stem, flower-stalks, fruits, &c.; but in all cases in the epidermis only. They usually have the form of hemispheres attached to the wall; and are radiate or even spined. As in *Cocculus*, they are not found in every epidermal cell, but in groups in adjoining cells, and attached to the adjacent transverse walls. They are insoluble in cold or boiling water, and in dilute mineral or organic acids; soluble in concentrated sulphuric acid with a golden yellow colour, and in potash-ley or hot nitric acid. The reactions indicate a probability that they are composed of hesperidin. Their insolubility in alcohol shows that they cannot consist of any compound of conia.

Respiration of Detached Shoots.†—It is an established fact that a sprig of a plant, if placed for some hours in an atmosphere of carbonic acid and then removed and placed in the dark, exhales a more than normal amount of carbonic acid. This has been stated to be due simply to the giving up of carbonic acid which has been taken in in excess, but not assimilated. J. Borodin combats this conclusion with the following arguments:—

The activity of respiration of a detached twig is not constant, even when the conditions are constant; it becomes less in the dark. This

* Ber. Naturf. Ges. Halle, 1881, pp. 41–3.

† Mem. Acad. Imp. Sci. St. Petersbourg, xxviii. (1881) No. 1. Cf. Naturforscher, xiv. (1881) p. 463.

diminution is due to gradual exhaustion of the supply of carbo-hydrates, for if carbo-hydrates are assimilated afresh the activity of respiration takes a new start.

That this renewed activity is caused by assimilation and not by simple absorption of carbonic acid is shown by the fact that (1) both light and carbonic acid are necessary to the commencement of this condition; (2) insolation is useless without carbonic acid; (3) an atmosphere rich in carbonic acid is useless without light; (4) a small proportion of carbonic acid is sufficient, if combined with light; (5) absorption of oxygen undergoes increase after insolation; (6) the intensity of the light is of importance; sunlight is best; (7) the more refrangible rays take part in the action.

Absorption of carbonic acid may take place to a slight extent, in addition to the assimilation; but it only occurs after a sojourn in a richly carbonized atmosphere, and it passes off in from one to two hours. The solid parts take an active part in the absorption; seeds apparently absorb as much (in relation to their weight) in a dry as in a soaked state. Dry seeds absorb only insignificant quantities of hydrogen.

Physiological Functions of the Tissues of Plants.*—G. Haberlandt occupies a section of Schenk's 'Handbook of Botany' ('Encyklopædie der Naturwissenschaften') with an exhaustive account of the various kinds of vegetable tissue, and of the parts which they fulfil in the economy of the plant; treating the subject from a Darwinian point of view, i. e. regarding the anatomical structure and arrangement of tissues as a series of phenomena of adaptation. The following is his classification of tissues:—

I. Epidermal System.
  1. Epidermis. 2. Cork. 3. Bark.

II. Skeletal System.
  1. Bast and libriform. 2. Collenchyma. 3. Sclerenchyma (?).

III. Nutritive System.
  1. Absorptive System (Epithelium of the root, root-hairs, &c.).
  2. Assimilative System (Chlorophyll-parenchyma; palisade tissue).
  3. Conductive System (Conducting parenchyma; conducting bundles [mestome, hadrome, leptome]; parenchyma-sheaths; laticiferous vessels).
  4. Aerative System (Tracheal System (?); air-conducting intercellular spaces with their orifices [stomata and lenticels]).

Local structures. Endoderm; thickened vascular bundle-sheaths; glandular, oil-, mucilage-, and gum-passages, &c.

The following definitions are also given: *Protoderm* consists of

* Schenk's Handb. der Bot., ii. pp. 557–693 (28 woodcuts). Breslau, Trewendt, 1882. See Bot. Centralbl., xi. (1882) p. 158.

the peripheral layer of merismatic cells; *Cambium* of parenchymatous cells with narrow cavity, usually united into longitudinal bundles; *Fundamental parenchyma* is the tissue which remains after the differentiation of the protoderm and cambium.

Chlorophyll and Hypochlorin.*—A. Tschirch gives the following as the results of a series of fresh observations on chlorophyll and its derivatives.

Pringsheim's hypochlorin (at all events as regards the greenish yellow needles) is a product of the action of acids on the colouring matter of chlorophyll, and can be produced outside the plant in the well-known crystals. To distinguish this from the possible colourless matrix, which has, however, not yet been satisfactorily separated, the author calls it α-hypochlorin. It is identical with Hoppe-Seyler's chlorophyllan, and with the precipitate which appears spontaneously when solutions of chlorophyll have stood for some time. All the substances belonging to this group are products of oxidation of a portion of the chlorophyll. Chlorophyllan, or α-hypochlorin, can easily be obtained pure in the form which Pringsheim has described, by laying leaves of grass which have been freed by ether from oil and wax, for some days in hydrochloric acid, carefully washing out the acid, and extracting with boiling alcohol. When the filtrate cools abundance of α-hypochlorin precipitates, which can be increased by distilling off a portion of the alcohol. It crystallizes in the form of dark brown (or greenish in incident light) radiating needles; the whip-like form results from the impurity of the solution.

The formation of chlorophyllan in the living plant is due to the presence of organic acids. With the exception of water-plants, the author found none in which the cell-sap has not a distinct acid reaction. When the proportion of acid is only small, the chlorophyllan is only formed by allowing the extract to stand for a long time; carbonic dioxide produces it at once. The extracts of strongly acid leaves like those of *Aesculus* or *Rumex*, deposit chloryphyllan simply on cooling. The formation is completely prevented by giving an alkaline reaction to the extract.

It is probable that many of the described modifications of chlorophyll depend on the variation in the proportion of acid present in the cell-sap, and in the variable solubility of the acids in the solvents employed.

The cause of the absence of hypochlorin from the chlorophyll-grains in many plants, even when lying in an acid cell-sap, is the fact which Tschirch has established, and which had already been assumed on theoretical grounds by Naegeli and Pfeffer, that every grain of chlorophyll is surrounded by a colourless hyaloplasmic layer, which may frequently be clearly made out, especially in water-plants. In the living state this hyaloplasmic layer is not permeable to acids; it is consequently only after death that the acid cell-sap enters and produces α-hypochlorin.

In a subsequent communication Tschirch further criticizes Prings-

* SB. Bot. Ver. Prov. Brandenburg, 1882, pp. 41–5, 124–34.

heim's arguments, and agrees with his conclusion that the first product of assimilation must be a substance containing less oxygen than had previously been supposed. There is also a good deal in favour of the view that this substance is Pringsheim's hypochlorin; but on the whole the author considers it more probable that it is a product of decomposition of the colouring matter of the chlorophyll, formed only on the addition of reagents. The statement of Pringsheim that "in those cases where the chlorophyll-grains assume large dimensions, as in bands, plates, &c., it is easily seen that the hypochlorin does not appear everywhere where there is colour, but is localized to certain spots," is not confirmed by Tschirch's observations.

Function of Chlorophyll.*—Professor N. Pringsheim's latest contribution to this subject is chiefly occupied with an historical *résumé* of our knowledge, and a reply to objections from various sources to his previously published views, to which he adheres in all essential points. Pringsheim does not agree with the view of some other investigators † that the first product of assimilation is formic aldehyde. This is not in accordance with the fact that in the light the volume of oxygen evolved is equal to that of carbon dioxide decomposed, taken into consideration in connection with the simultaneous respiration of the plant. The total result can only be explained by the product of assimilation being a compound which contains a smaller proportion of oxygen than formic aldehyde.

Vitality of the Chlorophyll-pigment.‡—G. Kraus preserved fruits of *Cucurbita melanosperma* in an ordinary sitting-room for more than three years, at the end of which time mould began to appear on them. The non-chlorophyllaceous cells were then found to contain protoplasm and other cell-contents apparently unchanged. In the chlorophyllaceous cells, on the other hand, the chlorophyll-grains were transformed into green balls, having undergone a change similar to that of the autumn colouring of the leaves of the horse-chestnut. The colouring-matter of the chlorophyll appeared, however, to be entirely unchanged. An alcoholic extract gave the typical spectrum of chlorophyll with seven bands.

Action of various Gases on Plants.§—W. Detmer has experimented on the influence of various gases on living plants. He found the effect of nitrous oxide, hydrogen, and carbonic acid to be very similar, hindering the further development of seeds and seedlings, and preventing heliotropic curvatures and the greening in the light of etiolated parts of plants. Chloroform also acted disadvantageously on growth; but respiration was not suspended in an atmosphere containing much chloroform.

* Pringsheim's Jahrb. für wiss. Bot., xiii. (1882) pp. 377–490. Cf. this Journal, iii. (1880) pp. 117, 480; i. (1881) p. 479; *ante*, p. 220.

† See this Journal, *ante*, pp. 361, 362, 526.

‡ Ber. Naturf. Ges. Halle, 1881, pp. 43–5.

§ Landwirthsch. Jahrb., xi. (1882) p. 213. See Naturforscher, xv. (1882) p. 272.

Power of Plants to absorb Carbonic Oxide.* — L. Just has subjected *Azolla caroliniana* and *Lemna gibba* to a series of experiments for the purpose of determining whether plants can assimilate CO in the place of CO_2. He finds that this gas is not absorbed by green plants; but that it is injurious only when its proportion in the atmosphere exceeds 10 per cent. It then prevents the formation of chlorophyll, and hinders assimilation and growth. If the gas is then removed, the plant may partially recover. Chlorophyll-grains have no power of absorbing carbonic oxide. Control-experiments were also made on the same plants under the same circumstances with pure air entirely free from carbonic acid gas and with air containing the normal amount of this gas.

Formic Acid in Plants.†—In addition to the somewhat doubtful occurrence of free formic acid in the stings of the stinging-nettle and similar structures, A. Vogel records an undoubted instance in a powder which occurs in commerce made from the hairs of *Negretia pruriens.* The quantity, however, is very small, and the author thinks that, both in this case and in that of the irritating fluid of the stinging-nettle, the irritation is partly mechanical, due to the large amount of silica present in the part of the hair which enters the wound.

The presence of formic acid in the vegetable kingdom is easily explained by the oxidation of albuminoids and of carbonic acid, and by the action of oxalic acid on glycerine. In addition to the stinging-nettle, it has been detected in the leaves, bark, and wood of the spruce fir, in the sap of the house-leek (*Sempervivum tectorum*), and in the fruits of the tamarind, and of *Sapindus Saponaria.* Its well-known occurrence in honey, where it is accompanied by other vegetable acids, probably lactic, malic, and oxalic acids, is due to its excretion from the stinging-gland of the bee. The proportion present in new sugar averages about 1 per cent. It has the effect of hindering fermentation, and hence promoting the preservation of the honey.

Function of Lime-salts.‡—H. de Vries points out that there is hardly any experimental evidence in support of the ordinary theory of the part played in the life of the plant by calcium oxalate, viz. that the oxalic acid is a product of the albuminoids, and that its function is to decompose the calcium phosphate and sulphate, the lime being the carrier of phosphoric and sulphuric acids to the plant. On the contrary, the formation of albuminoids and of calcium oxalate appears to go on quite independently of one another, while protoplasm has an alkaline reaction, and cannot therefore contain free phosphoric or sulphuric acid.

The fact that the amount of lime deposited in the leaves increases continually with their age appears to point to the conclusion that it is an excretory product. The ordinary theory that calcium oxalate

* Forsch. aus dem Geb. der Agriculturphysik, v. p. 60. See Naturforscher, xv. (1882) p. 336.

† SB. Math.-phys. Klasse Münch. Akad., 1882, p. 345. See Naturforscher, xv. (1882) p. 355. Cf. Pharm. Journ., xiii. (1882) p. 269.

‡ Vries, H. de, 'Ueber die Bedeutung der Kalkablagerungen in den Pflanzen. 34 pp. (Berlin, 1881). See Bot. Centralbl., x. (1882) p. 194.

is insoluble in the cell-sap does not rest on a satisfactory basis; in some cases, on the contrary, it would certainly appear to be dissolved, and in this state to pass through the cell-wall. It is, however, soluble with difficulty; and the function of oxalic acid seems to be to get rid, in this form, of what would otherwise be an injurious excess of lime. Lime and oxalic acid are both present in soils in greater quantity than is needed by the plant; and their excess is consequently excreted by the plant in an insoluble form, or at least one that is soluble only with difficulty.

Function of Resinous Substances.*—H. de Vries has investigated this subject in detail, especially in reference to the terebenthin and resin produced by conifers; and urges arguments in opposition to the generally accepted view that these substances are simply waste products of an excretory nature. Terebenthin is the substance most rich in carbon which occurs in conifers, and its production requires, in consequence, the consumption of a relatively large quantity of assimilated substances, especially of glucose, from which it is probably formed only by a long series of chemical transformations; and its production can in no sense be regarded as analogous to that of gum in wounded cherry or plum trees. It must, on the contrary, be looked on as a normal and important function in the life of conifers. As long as the reservoirs in which it is formed remain closed, this resin undergoes no change; but whenever the organ is wounded, it flows out in the form of a thick viscid mass, which gradually hardens on exposure to the air. But it not only spreads over the surface of the wound, it penetrates also to the interior of the wood, fills the cell-cavities, and saturates the cell-walls.

According to their direction, the resin-canals of the wood and bark of conifers may be classified into horizontal and vertical; the former are found especially in the medullary rays.

Briefly, the object attained by conifers in sacrificing so large a quantity of food-material in the production of resinous secretions, is the acquisition of a substance which furnishes a complete remedy against a great variety of injuries to which the woody tissues are subject.

The author then investigates the functions of similar secretions formed by other orders of plants, especially that of resinous substances, gums, and latex. The entire absence of substances of this nature in large groups of plants, as the Palmæ, Cyperaceæ, Gramineæ, and the greater number of Cruciferæ and Ranunculaceæ, indicates that their function must have relation to special circumstances. That the function of all these substances is similar is further indicated by the fact that they replace one another in different plants or groups of plants, it being very unusual to find more than one kind in the same species. Again, under normal conditions, they are never resorbed out of their reservoirs to take part in other nutritive processes; as long as they remain in their reservoir they are completely inactive. In this situation they are always subject to a certain pressure which

* Arch. Néerland. Sci., xvii. (1882) pp. 59–82.

causes them to flow over the surface of the wound when the reservoir is injured.

All the substances produced by the hardening of latex and the other resinous fluids in contact with the air, resin, caoutchouc, wax, &c., are glutinous, and are admirably adapted for the protection and healing of wounds. On escaping from their receptacle they are decomposed into two parts, a thin liquid fluid, and the thick mucilaginous substance which was previously dissolved in the first. Their function, in fact, appears to be identical with that of the resin and terebenthin of conifers. One of the injurious results of wounds which they prevent is the settlement and germination in the exposed tissue of the wounded part of the spores of parasitic fungi.

In plants and organs of the simplest structure, such as Thallophytes, mosses, and the prothallia of ferns, the process of recuperation after a wound is simply that the injured cells die and are not replaced, the uninjured cells in contact with them carrying on the life of the individual. In plants of higher organization, on the contrary, the injured tissue must be replaced by a freshly formed tissue, which process is carried on under the protection of these resinous secretions. This new tissue is of the nature either of callus or of traumatic bark, both resulting from the segmentation of cells by cell-walls parallel to the surface, new layers being formed in this way, the walls of whose cells are subsequently impregnated with suberous matter.

Change of Starch into Sugar at low temperatures.*—H. Müller-Thurgau has experimented on the sweetening of potatoes by frost, depending on the conversion of starch into sugar. He finds that it depends on the freezing taking place slowly, and on the temperature sinking to at least $-3°$ C. When once begun the process goes on rapidly. Different kinds of potatoes exhibit very different properties in this respect, and the presence of a large amount of water promotes the sweetening. The transformation is occasioned by a diastatic ferment, the propagation of which is promoted by a low temperature.

Colours of Flowers.†—In an article by Grant Allen, on "The Colours of Flowers, as illustrated in the British Flora," the author says that the different hues assumed by petals are all, as it were, laid up beforehand in the tissues of the plant, ready to be brought out at a moment's notice. And all flowers, as we know, easily sport a little in colour. But the question is, Do their changes tend to follow any regular and definite order? Is there any reason to believe that the modification runs from any one colour towards any other? Apparently, there is. All flowers, it would seem, were in their earliest form yellow; then some of them became white; after that, a few of them grew to be red or purple; and, finally, a comparatively small number acquired various shades of lilac, mauve, violet, or blue.

Some hints of progressive law in the direction of the colour-change from yellow to blue are sometimes afforded us even by the

* Naturforscher, xv. (1882) pp. 349–51.

† Allen, Grant, 'The Colours of Flowers as illustrated in the British Flora.' 119 pp. (8vo, London, 1882.) Cf. Bull. Torrey Bot. Club, ix. (1882) pp. 117–8.

successive stages of a single flower. For example, one of our common little English forget-me-nots, *Myosotis versicolor*, is pale yellow when it first opens; but as it grows older, it becomes faintly pinkish, and ends by being blue, like the others of its race. Now, this sort of colour-change is by no means uncommon; and in almost all known cases it is always in the same direction, from yellow or white, through pink, orange, or red, to purple or blue. Thus one of the wall-flowers, *Cheiranthus chamœleo*, has at first a whitish flower, then a citron-yellow, and finally emerges into red or violet. The petals of *Stylidium fruticosum* are pale yellow to begin with, and afterwards become light rose-coloured. An evening primrose, *Œnothera tetraptera*, has white flowers in its first stage, and red ones at a later period of development. *Cobœa scandens* goes from white to violet; *Hibiscus mutabilis* from white, through flesh-coloured, to red. The common Virginia stock of our gardens (*Malcolmia*) often opens of a pale yellowish green, then becomes faintly pink, afterwards deepens into bright red, and fades away at last into mauve or blue. Fritz Müller noticed in South America a *Lantana*, which is yellow on its first day, orange on the second, and purple on the third. The whole family of *Boraginaceæ* begin by being pink, and end by being blue. In all these, and many other cases, the general direction of the changes is the same. They are usually set down as due to varying degrees of oxidation in the pigmentary matter.

If this be so, there is a good reason why bees should be specially fond of blue, and why blue flowers should be specially adapted for fertilization by their aid; for bees and butterflies are the most highly adapted of all insects to honey-seeking and flower-feeding. They have themselves, on their side, undergone the largest amount of specialization for that particular function. And if the more specialized and modified flowers, which gradually fitted their forms and the position of their honey-glands to the forms of the bees or butterflies, showed a natural tendency to pass from yellow, through pink and red, to purple and blue, it would follow that the insects which were being evolved side by side with them, and which were aiding at the same time in their evolution, would grow to recognize these developed colours as the visible symbols of those flowers from which they could obtain the largest amount of honey with the least possible trouble. Thus it would finally result that the ordinary unspecialized flowers, which depended upon small insect riff-raff, would be mostly left yellow or white; those which appealed to rather higher insects would become pink or red; and those which laid themselves out for bees and butterflies would grow for the most part to be purple or blue. Now, this is very much what we actually find to be the case in nature.

Causes of the Etiolation of Plants.*—E. Mer points out that the aquatic forms of amphibious plants present, in their external appearance and internal structure, a close analogy with the forms of aerial plants grown in the dark or in moist air. A comparison of these phenomena shows that etiolation is the result of a variety of

* Comptes Rendus, xcv. (1882) pp. 487–9.

causes of different importance acting together or separately. When the stem is rudimentary or reduced to a bulb, and the leaves are sessile, the nutritive equilibrium exercises only a feeble influence, since the nutritive materials are all collected in one organ; the relative dimensions only of this organ are modified. The most complex case is where the causes of etiolation combine, as when an aquatic plant, furnished with a stem and petiolate leaves, is immersed in the dark, as occurs in the first leaves of water-plants growing at a great depth.

Origin of Galls.* — In opposition to the view of Dr. Adler, J. Paszlavszky has established that all rose-galls arise in leaf-buds which have been punctured by *Rhodites rosæ.* The female works in three directions corresponding to the phyllotaxis of the rose, laying her eggs, which are provided with a long stalk, on the three leaves which constitute a whorl.† All galls become in this way circular by the shortening of the internodes. All terminal galls are originally circular, and have become terminal by the gradual withering of the leaves from the apex downwards. The ultimate form of the gall depends greatly on the number of larvæ that develope within it.

B. CRYPTOGAMIA.

Muscineæ.

Male Fructification of Polytrichum.‡—K. Goebel investigates the phenomena connected with the habitual prolification of the antheridial receptacle or male fructification of *Polytrichum.*

He finds that Leitgeb's rule, derived from the case of *Fontinalis,* that the first antheridium springs from the apical cell, and is the termination of the primary axis, is not of general application. In *Polytrichum,* on the contrary, the large apical cell of the primary axis may be recognized in the middle of the fructification; the first antheridium cannot therefore proceed from it. From each leaf-forming segment beneath the leaf springs a group of antheridia. It follows from this that the antheridia which form a group do not stand at the same height, but are arranged in two or three superposed rows. Among them stand a great number of densely packed paraphyses, which, together with the somewhat modified leaves, completely enclose the antheridia. A leaf is produced of each segment of the apical cell. The growing point of the stem is not, as in *Fontinalis* and other genera, slender, but flattened, somewhat as in *Lycopodium Selago.* At a later period, when the antheridia are mature, the growing point even lies in a cup-shaped depression. The flattening of the growing point is caused by the growth of each segment being stronger in its upper portion nearest the surface of the stem than in its lower part. From the base of the young leaves hairs spring at an early period on the side which faces the apical cell; antheridia have never been observed in this position.

* Naturforscher, xv. (1882) p. 308.

† The phyllotaxis of the rose is 2–5, five leaves making up two whorls.—Ed.

‡ Flora, lxv. (1882) pp. 323–6 (1 pl.).

The development of the separate antheridia agrees with that of *Fontinalis*; they have a 2-edged apical cell, which produces two rows of segments. The youngest stage shows two inner cells surrounded by a number of parietal cells. The further arrangement of the cells in subsequent divisions probably differs in different genera.

It follows from what has been said, that in *Polytrichum*, the antheridia do not, as is generally stated, stand in the axils of the leaves, and that their arrangement differs from what has been previously observed. While in *Fontinalis* and other genera of mosses, the antheridia differ in their place of origin, the first springing from the apical cell, the next in place of the leaves, the subsequent ones having no definite point of origin, in *Polytrichum* all the antheridia have the same origin, viz. beneath the leaves from outer cells of the tissue of the stem which belong to the same segment as the leaf. This fact furnishes another illustration of the general law that the place of origin of an organ does not determine its morphological value.

Fungi.

Epiplasm of Ascomycetes—Glycogen of Plants.*—The following are the principal conclusions of Dr. L. Errera on this subject, the method adopted for extracting glycogen from fungi and other plants being that of Brücke,† slightly modified in some cases.

1. Glycogen or "animal starch" exists not only amongst the animals in which Claude Bernard discovered it, and in the Protista (where it was first pointed out by Kühne), but is also found in plants.

2. Many of the ascomycetous fungi contain it in their tissues and in their asci. *Pilobolus,* and, almost certainly, the yeast of beer, equally contain it. The identity of the glycogen of *Peziza vesiculosa* (which the author has studied most in detail) with the glycogen of the liver of Mammalia is complete.

3. The epiplasm of the asci of Ascomycetes, suspected by Tulasne and described by de Bary, is formed of a spongy mass, probably albuminous, completely permeated with glycogen.

4. Even outside the fungi, all the plants studied (*Lemanea*, *Linum*, *Mahonia*, *Solanum*) contain substances at least analogous to glycogen, non-nitrogenous, giving more or less opalescent aqueous solutions which turn more or less brown with iodine, having no reducing action whatever on the cupro-alkaline reagents, but becoming transformed into reducing bodies by boiling with dilute sulphuric acid.

5. There also exist reducing substances analogous to the dextrines in the aqueous extracts of several plants (*Tuber*, *Agaricus*, *Solanum*); in others they have not been found (*Peziza*, *Lemanea*).

6. When it is not in too small a quantity the glycogen may be

* Errera, L., 'L'Epiplasme des Ascomycètes et le Glycogène des Végétaux.' 81 pp. (8vo, Bruxelles, 1882).

† SB. K.K. Akad. Wiss. (Wien), lxiii. (1881) p. 214; and Vorles. über Physiol., i. (1881) p. 324.

determined by microchemical means, by its appearance, by its semi-fluid consistency, by the absence of reaction with osmic acid, Millon's reagent, and the salts of iron, by its solubility in water, and by its assuming with iodine a mahogany-brown or brown-red colour, which dissipates with heat and reappears on cooling. The proteid substances, on the contrary, become yellow rather than brown with iodine, and this colour is not diminished by moderate heating.

7. The glycogen of the Ascomycetes, at first diffused throughout the whole of the young plant, as it is in the animal kingdom in the fœtus, soon accumulates in the asci in considerable quantity, and disappears gradually as the spores ripen.

8. It is utilized in the development of the spores. Besides its eventual function of a respiratory reserve, there are good reasons for supposing that in the truffles, and probably also in other Ascomycetes, it furnishes materials for the formation of the oil of the ripe spores.

9. Around glycogen and starch are ranged some allied substances. It is thus that we are led to place in contact to one another a *glycogen group and a starch group.* We may, with Boehm and Hoffmann, rank with the former the glycogen of the liver and that of the muscles, xantho-glycogen, achro-glycogen, and glycogen-dextrin; and among the latter, starch, the amylo-dextrins, and inulin.

10. Glycogen, glycogen-dextrin, starch, amylo-dextrin, and inulin do not give true solutions with water; they only form a kind of magma, more or less thin, in which the greater portion of the substance is mechanically suspended. This fact helps us to understand the storing up of glycogen and inulin in particular cells.

Agaricini.*—In a review of our present state of knowledge of the Agaricini, S. Schulzer holds that the generic classification of *Agaricus* according to the colour of the spores, though not a natural classification, is the most convenient at present proposed. The division into subgenera is not so satisfactory; and he adduces several instances in which a series of forms belonging to the same species must be placed some in one and some in another subgenus.

With regard to the genera of Agaricini outside *Agaricus*, he considers that there is no sufficient distinction between *Cantharellus* and *Craterellus*, nor between *Panus* and *Lentinus*. *Marasmius* also should be united with *Agaricus*.

Development of Sclerotium of Peziza Sclerotiorum.†—Correcting some mistakes in the account previously given by Brefeld and Coemans, O. Mattirolo gives the following description of the mode in which the cup of *Peziza Sclerotiorum* is formed out of the sclerotium:—

The sclerotium varies greatly in form; but a cortical layer from two to four cells in thickness can always be distinguished from the medullary portion. The first rudiments of the cup make their appearance in the outer medullary layers. The hyphæ divide and become

* Oesterr. Bot. Zeitschr., xxxii. (1882) pp. 186–9, 220–5, 250–3.
† Nuov. Giorn. Bot. Ital., xiv. (1882) pp. 200–12 (2 pls.).

closely entangled, but without an ascogonium being distinguishable; a small endogenous ball of slender hyphæ being thus formed, which continues to increase in size, and finally bursts through the cortical layers which have bulged out into a spherical form. From this ball a string of hyphæ grows upwards, surrounded by a cylinder of thicker hyphæ derived from the detached outer medullary layers of the sclerotium. These outer coarser hyphæ form the cortical layer of the cup, the inner bundle developes into the medullary layer of the stalk, and later into the hymenium. The body thus formed is at first cylindrical; the cortical hyphæ diverge at their distal end, and thus form a club-shaped structure; while the finer central hyphæ converge distally. In the middle of the bundle the hyphæ cease after a time to increase in length; while the outer ones continue to grow, and thus form an elongated cylinder. The wall of this canal is clothed with the ascogenous ends of the hyphæ. At a later period the canal becomes wider above, becoming first funnel-shaped and the margin then expanding flat, thus forming the well-known cups of *Peziza Fuckeliana*. At first paraphyses only are visible on the disk; the asci are first formed in the centre, and gradually extend to the margin. Usually several are formed on the thickened end of each hypha; but the ascogenous hyphæ appear to have the same origin as the sterile ones which become paraphyses.

Development of the Sporangia of the Phycomycetes.*—M. Büsgen describes the mode of development of the sporangia and of their zoospores in the following genera of Phycomycetes:—*Dictyuchus*, *Leptomitus*, *Saprolegnia*, *Achlya*, *Aphanomyces*, *Phytophthora*, *Cystopus*, *Pythium*, *Peronospora*, and *Mucor*.

These exhibited several distinct modes of spore-formation. In some cases a number of spores are developed within the sporangium to more or less complete isolation. In these cases cell-plates are formed, the entire contents of the sporangium dividing, but not always simultaneously, into nearly equal portions. The cell-plates then partially or entirely deliquesce into a hyaline mass, finally disappearing altogether. At the same time the structure of the protoplasm contained in the sporangium changes; it becomes more uniformly granular and transparent, a large number of small round vacuoles appearing at the same time. These partially disappear, and fresh cell-plates are again formed. Each of the portions of protoplasm separated by them contains one of the small vacuoles, and is the protoplasm of the subsequent spores. The cell-plates either form the cellulose-membranes of the spores or pass over into intercellular substance.

In *Aphanomyces* there are, however, no cell-plates; and the mode of formation of the intercellular substance presents a difficulty. It may be produced in the way described by Strasburger in the case of some swarm-spores, or it may be regarded, with de Bary, as a secretion from the mature spores.

An analogous production of temporary cell-plates has been

* Pringsheim's Jahrb. f. wiss. Bot., xiii. (1882) pp. 253–85 (1 pl.).

observed by Strasburger in the formation of the pollen of some phanerogams and of the spores of some vascular cryptogams, and in the formation of the endosperm in the embryo-sac.

The mode of formation of the zoospores of *Phytophthora* agrees with that already described in the Saprolegnieæ. In *Pythium* the formation of cell-plates is in most cases very doubtful.

The question of the presence or absence of the cell-nucleus in the sporangia presents many difficulties. In some cases round or lenticular bodies exhibiting the reaction of nuclein can be made out with certainty. In *Leptomitus* it is especially distinct, each spore possessing one nucleus. In other cases each spore contained two nuclei; while in others the presence of a nucleus could not be certainly demonstrated.

The processes which take place in the formation of the zoospores within the sporangia of the Phycomycetes must be regarded as falling within Strasburger's definition of true cell-division.

Alternation of Generations in the Hypodermiæ.*—M. Cornu has been able to produce the aecidium of *Puccinia arundinacea* on *Ranunculus repens* from spores, but not abundantly, and always late in the year, viz. in October and November. This species does not attack *R. bulbosus*, *acer*, *sceleratus*, or *Flammula*, or *Lonicera*. *Ranunculus acer*, *bulbosus*, and *repens* are, however, also subject to the attacks of an aecidium derived from *Uromyces graminum* Cooke; the ranunculaceous plants *Aquilegia vulgaris*, *Actæa spicata*, *Aconitum Napellus*, and *Hepatica triloba* support aecidia which are considered to be distinct from the above. The puccinia-form of *P. arundinacea* occurs on *Arundo Phragmites;* thus the species inhabits plants of very different characters at different stages of its life-history.

"Mal Nero" of the Vine.†—O. Comes has determined that this widespread disease is caused by a production of gum like that to which stone-fruit trees are liable, the result of insufficient nutrition; and that the fungi which always accompany it are a secondary phenomenon only. The best cure is copious manuring, and especially the abundant supply of phosphates and lime-salts.

Aubernage: a Disease of the Vine.‡—For some time past a disease of the vine called "Aubernage" has shown itself at Auxerre in the department of Yonne, with most disastrous results. After first small and then large spots have appeared on the branches, a rapid disorganization of the tissue of the wood commences, which, beginning at the extremities of the branches, spreads downwards to the roots and completely destroys the plant. C. Roumeguère has proved the existence of three fungi in the diseased branches. *Phoma vitis* Bk. & B., *Phoma pleurospora* Sacc. var. *forma vitigena*, and *Sphaerella pampini* Thm., and believes that in the joint action of these fungi he has discovered the true cause of the disease.

* Comptes Rendus, xciv. (1882) pp. 1731–4.
† L'Agricolt. merid. Portici, v. (1882) pp. 64–72. See Bot. Centralbl., xi. (1882) p. 97. Cf. this Journal, *ante* p. 229.
‡ Revue Mycol., iv. (1882) pp. 1–3. See Bot. Centralbl., xi. (1882) p. 98.

Parasites of the Saprolegnieæ.*—A. Fischer has made a detailed examination of the group of minute fungi parasitic on the Saprolegnieæ, which were at one time taken for the reproductive organs of their hosts, the organisms themselves for antheridia, their zoospores for spermatozoids. They comprise the three genera *Olpidiopsis* Cornu, parasitic on *Saprolegnia ferax*, *Rozella* on *S. dioica*, and *Woronina* on *Achlya dioica*. The mode of observing them adopted was to cultivate the *Saprolegnia*, &c., on larvæ of ephemerides, which became completely covered with the fungus in twenty-four hours, the parasite always attacking the latter after the course of a few days.

After a general description, applying to the whole group, of the structure and movement of the zoospores, and the mode in which the parasite penetrates the host, in extension of previous observations on the same points,† the author proceeds to a separate description of each genus.

Olpidiopsis is distinguished by its nearly spherical or shortly elliptical sporangia with smooth surface, which are found in swollen and deformed *Saprolegnia*-sacs. In addition to the ordinary zoospores, there occur also spined sporangia of the same size as the smooth sporangia, which perform the function of resting spores in the cycle of development of *Olpidiopsis*. The smooth spineless sporangia are developed both from the spores of the spineless and from those of the spined sporangia under favourable circumstances, a single sporangium only springing from each spore. The view of Cornu and others, that the spined sporangia are organs of a sexual nature, rests on inaccurate observation. The number of species of *Olpidiopsis* is probably much larger than has yet been described, the parasites of *Cosmarium* and other desmids probably belonging to this genus.

Rozella forms a number of closely packed sporangia in uninjured *Saprolegnia*-filaments. The wall of its sporangium is inseparable from that of its host. Like the last genus, it forms also spined sporangia. Each spore which penetrates the host developes within it a large number of sporangia, the spore appearing to lose its individuality, and its protoplasm to become intimately mingled with that of the host. The same is the case with the spores from the spined resting sporangia. This applies to the section of the genus described by Cornu, and which may be termed the *septigena*-group; in another section the spore-forming organs are solitary.

Woronina is characterized by the formation of a sorus. The filament is divided by septa, and in each chamber is developed a sorus consisting of a larger or smaller number of sporangia. Each spore of the sporangial sorus gives birth again to a sorus, one generally springing from each spore. The author was not able to confirm the statement of Cornu that this genus produces also resting spined sporangia; the resting condition appeared, on the other hand, to consist of the accumulation into cysts of a large number of sori, forming what may be termed "cystosores," bodies resembling in external appearance

* Pringsheim's Jahrb. f. wiss. Bot., xiii. (1882) pp. 286–371 (3 pls.).
† See this Journal, i. (1881) p. 87.

the cystoliths of Urticaceæ. Only a single species has as yet been observed, parasitic exclusively on *Saprolegnia*.

In all stages of development of all three genera cell-nuclei have been observed. Each zoospore, on escaping, contains a nucleus. No sexual reproduction takes place in any of them.

Fischer gives the following as the distinguishing characters of the three genera :—

1. *Olpidiopsis*. The single spore developes as an individual directly into a sporangium.

2. *Woronina*. The single spore becomes enclosed as an individual in a soral chamber; it then loses its individuality, and transforms the entire contents of the chamber into a soral plasmodium. From each spore is developed a single sorus.

3. *Rozella*. The separate spores lose their individuality immediately after penetrating the host, and mingle their protoplasm with that of the host. In each division of the filament there is not therefore a plasmodium sprung from an entire spore, but only a part of one ; the plasmodium resulting from a spore fills the entire filament. From each spore proceeds a row of sporangia.

Olpidiopsis is the simplest form of the group, *Rozella* occupying the highest position, and the three genera are genetically connected as different stages of development. The life-history may be divided into two periods ; in the vegetative period it is a naked mass of protoplasm, spontaneously changing its form, a plasmodium ; the reproductive period is characterized by the separation of zoospore-producing organs.

The author considers that these three genera must form a group by themselves distinct from the Chytridiaceæ, which are characterized by a more or less developed mycelium and by a process of sexual reproduction.

Diastatic Ferment of Bacteria.*—J. Wortmann considers that the reason why bacteria do not, in the ordinary way, attack starch-grains, is that the starch is usually accompanied by albuminoid and other substances, from which the bacteria obtain their food-materials more readily. In order to determine the power of bacteria to decompose starch, this substance must be presented to them in a state of purity. Experiments in this direction yielded the following results :—

1. Bacteria have the power of producing in starch-grains, starch-paste, and dissolved starch the same changes as are caused by diastase.

2. Different kinds of starch are dissolved with different degrees of rapidity by bacteria, as by diastase.

3. The bacteria exercise this influence on starch only when no other serviceable carbon-compound is available, and when the access of air is not in any way impeded. Thus if only the slightest trace of tartaric acid is present in the fluid, the starch is not attacked ; but when this disappears, the starch at once begins to dissolve.

4. The action of bacteria on starch is brought about by a ferment

* Zeitschr. für physiol. Chimie, vi. p. 287. See Naturforscher, xv. (1882) p. 321.

which they excrete for this purpose, and which, like diastase, is soluble in water and precipitated by alkalies.

5. This ferment acts only diastatically, and does not peptonize; i. e. it transforms starch into a sugar which reduces copper-oxide.

6. The ferment itself can act on starch even in the absence of oxygen.

7. The ferment is excreted by the bacteria even in neutral solutions containing starch; and under these conditions without action.

8. The action of the ferment is accelerated in slightly acid solutions.

From these results Wortmann deduces the theory that bacteria produce a ferment which peptonizes albumen, but which has only a diastatic action on starch in the absence of albumen and other sources of carbon.

Bacteria of Intermittent Fever.*—A. Rózsahegyi confirms the observations of Klebs and Tommasi-Crudeli † with regard to the efficiency of filamentous bacteria in acting as carriers of the contagion of malarial fever. Placing a small quantity of the marshy soil of a malarial district of Hungary in a drop of solution of isinglass, he allowed this to stand in a warm place, when the malarial bacilli shortly made their appearance. When mixed with pure isinglass, the culture invariably succeeded at once; but if from one of these cultures a drop is taken containing abundance of bacilli and spores, and again placed in pure isinglass, this secondary culture succeeded only in about one-third of the cases. This is attributed by Rózsahegyi to the fact that, in addition to organic matters, the bacillus requires mineral constituents for its nutrition. For the secondary culture, heating to 50°–100° C. reduced the germinating power of the bacillus by about 2 per cent.; while a temperature between zero and 20·6° raised it by 50 per cent. Moist heat hence diminishes the germinating power, while moist cold increases it. The resting spores were killed only by an exposure for two hours to a temperature of 190°–195°.

Bacterial Parasite of the Chinch Bug.‡—In the course of some experiments upon the chinch bug, S. A. Forbes was annoyed by their rapid disappearance, and, crushing some, examined their fluids under the Microscope. In every case these were found to be swarming with a species of *Bacterium* not easily distinguishable from *B. termo*. The observations were many times repeated with every precaution against accidental infection, but with the same results.

Careful search in the juices of the corn upon which the insects were feeding, failed to discover anything of the kind there, and if a bug were thoroughly washed in a drop of distilled water no bacteria occurred in the water, showing that they were not derived from the surface of the insect. When a number were kept for a week in a

* Biol. Centralbl., ii. (1882). See Naturforscher, xv. (1882) p. 196.
† See this Journal, i (1881) p. 287.
‡ Amer. Natural., xvi. (1882) pp. 824–5.

bottle without food, the bacteria were found to have greatly increased in numbers, and were especially abundant in those which were recently dead. Dissections were made for the purpose of ascertaining whether the seeming parasites could be traced to the alimentary canal and in five cases the digestive organs were isolated and crushed. In all these cases the bacteria were very abundant, and could be seen issuing from the stomach in adherent masses, and also in motion separately in all parts of the field. In two cases where a comparison could be made between the contents of the anterior and posterior parts of the canal, they were found much the most numerous in that part of the canal posterior to the Malpighian tubes. The author therefore concludes that they have their principal, perhaps exclusive, seat in the alimentary canal.

Similar experiments made upon chinch bugs taken from the field, gave similar results throughout; but nothing of the sort could be detected in the fluids of the corn-plant louse (*Aphis maidis*) feeding upon the same stalks, nor in any of a number of insects examined.

Etiology of Distemper.*—Dr. R. Koch has collected together the literature which records the experiments that have been hitherto made respecting the cause of the distemper (*Milzbrand*) of cattle, and attempts to settle various disputed points connected with it.

Koch considers that a frequent source of error in the recorded results is the existence of other infectious complaints, as for example, septicæmia, which present a strong similarity to the distemper, and which are caused by similar bacilli. No certain method of distinguishing these various bacilli has yet been indicated. In opposition to the view of Pasteur that the disease always results from injury to the digestive organs, Koch maintains that infection may be carried from the intestines to other parts of the body when in a normal condition. Buchner's statement † that the bacilli of hay and of distemper can be mutually transformed one into the other, he also regards as resting on insufficient evidence, the requisite care not having been taken to exclude the possibility of the entrance of foreign bacteria into the culture. His own experiments showed that the distemper-bacilli could go through a very large number of generations unchanged, and still retain as great virulence as if they had been just removed from infected blood.

The author regards Pasteur's assertion, that "the etiology of distemper has been discovered, and with it the prophylaxis of this disease" as premature, many questions regarding it being still undecided. In conclusion, he discusses the question whether the bacilli of this disease can go through their course of development independently of the animal organism. He considers the evidence to be in favour of the conclusion that distemper makes its appearance in localities where dead bodies affected with it have never been buried, and where there is no reason to suppose that infected animals can

* Koch, R., "Zur Aetiologie des Milzbrandes," Struck's Mittheil. aus d. K. Gesundheitsamte, i. (1881). See Bot. Centralbl., x. (1882) p. 289.

† See this Journal, *ante*, pp. 89, 382.

have brought it. He considers that it can be clearly established that these bacilli can produce spores and go through all stages of development without coming into contact with any animal substance; propagating themselves extensively on vegetable substrata in moist situations during the warm months; the spores retaining their power of vitality through the winter.

Experimental Production of the Bacteria of Distemper.*—H. Buchner has experimented on the methods by which the infectious fungus of distemper can be artifically transformed into the harmless hay-bacterium. Of the latter he considers the correct name to be *Bacterium subtile.* The transformation is effected by means of a contrivance which is described in detail, by subjecting the infectious fungus to the influence of abundant supply of food-material and abundant oxygen. From the true distemper-bacteria, with clear nutrient fluid and delicate white clouds at the bottom, three transition-stages are thus obtained, viz.—

1. Nutrient fluid clear or clouded with flecks; a white rim formed where the surface of the fluid touches the glass; white flecks at the bottom of the fluid.
2. Fluid clouded with flecks; very loose pellicle with a mucilaginous appearance, which sinks to the bottom with the least shaking; bottom covered with flecks and fragments of the pellicle.
3. Fluid clear or clouded with flecks; pellicle consistent, but with a mucilaginous appearance; no flecks at the bottom.

These lead to the true hay-bacteria; when these only are present, the nutrient fluid is completely clear, and there is a dry, firm, white pellicle often finely wrinkled, with a pulverulent appearance, and easily submerged.

Germs of Malaria.†—In continuation of the researches of Tommasi-Crudeli and Klebs,‡ A. Ceci has further investigated the conditions under which malarial germs germinate in the soil. He concludes that in the atmospheric air and in the soil there are usually only germs or spores, which can develope under certain favourable conditions into more highly organized forms. This development almost invariably causes, in the fluids and moist substances in which it takes place, certain chemical changes, which are collectively known as fermentation. When the development takes place in nitrogenous or albuminoid substances, the highest kind of fermentation or putrefaction ensues. The effect of heat upon the germs is to retard their development, and consequently the fermentation or putrefaction. The fermentation produced by the germs in animal organisms, or fever, is retarded by the same agencies. The development of the germs may take place without causing fermentation, and is then apparently harmless.

The succession of generations of the organisms which occurs

* SB. K. Bayer. Akad. Wiss. München, 1882, pp. 147–69. See Bot. Centralbl., xi. (1882) p. 239. Cf. this Journal, *ante*, p. 89.

† Arch. f. experim. Path. u. Pharmak., xv. p. 153, and xvi. p. 1. See Naturforscher, xv. (1882) p. 332.

‡ See this Journal, i. (1881) p. 287.

under artificial conditions hinders the putrefaction which the lower organisms occasion in nitrogenous fluids, and may even entirely stop it. This appears to the author to account for the gradual subsidence and ultimate complete disappearance of fevers and other ferment diseases caused by them. In malaria, these organisms appear to lose their infectious properties very rapidly, and thus become incapable of conveying the malady from one infected animal nidus to another. Under favourable conditions they may however return to the condition of natural germs, and become once more infectious. In this way malaria may be conveyed by human subjects from an infected district to one previously free. The rapidity with which this reversion of the germs to their natural condition takes place may be the cause of the extreme contagiousness of such diseases as the distemper of cattle.

Prevention of Fermentation by Vegetable Acids.*—M. Märcken gives the following as the proportions of various acids which prevent a solution of sugar from fermenting:—acetic acid 0·5 per cent.; formic acid 0·2, propionic acid 0·1, butyric acid 0·05 (or completely when 0·1 per cent. is present), and a mere trace of capronic acid. A proportion of 0·6 per cent. of acetic or 0·05 per cent. of butyric acid in a nutrient fluid prevents the increase of yeast; while as much as 3·5 per cent. of lactic acid is required for the same purpose.

Fermentation of Maize-starch.†—V. Marcano has investigated the process of fermentation in "chicha," an alcoholic liquid prepared by the American Indians from maize-grains. He states the fermentation to be due to the reproduction of a very characteristic organism, which has three forms of development, as a vibrio, as nucleated torula-like globules, and as myceloid tubes, from which, at a certain period, vibrios escape, the membrane which forms the septa of the filament being at the same time resorbed. It is found in the exterior pellicle of maize-grains, and can be transformed from one form into another by culture in different nutrient fluids.

The ferment of chicha is further characterized by the property of acting directly on young starch, such as that contained in the embryo of maize-grains; the products of decomposition being dextrin, alcohol, and carbonic acid gas. The starch-grains on which it has acted are reduced to the condition of flakes of cellulose-starch (farinose), all the granulose having disappeared.

The organism resists the action of boiling water at 95° C. continued for some minutes; the most favourable temperature for its production being 40°–45°. It can also ferment milk-sugar, saccharose, and glucose. During the germination of maize, the vibrios develope in the interior of the grain in vast numbers. They have also been detected in the stem, immediately beneath the bark, and in the leaves.

The facts here recorded are considered by the author to explain the

* Zeitschr. f. Spiritusindustrie, iv. (1881) p. 114. See Bot. Centralbl., xi. (1882) p. 299.

† Comptes Rendus, xcv. (1882) pp. 345–7.

phenomenon of the resorption of starch-grains; and of the rise of temperature which takes place during germination; as also the production of other substances, hitherto unexplained, in the elaborated sap.

Fermentation of Nitrates.*—The researches of MM. Schloesing and Muntz have proved that nitrification, in the ground and in organic liquids, is due to development of small organisms (*corpuscules brillants* of Pasteur).† MM. Gayon and Dupetit having been led to think that the opposite process, viz. reduction of nitrates, is also a physiological phenomenon, have investigated the matter experimentally, and found a microbe which attacks nitrates in presence of organic matters (e. g. sewage water containing a little nitrate of potash with some altered urine, or preferably, chicken-broth) which cause the products of fermentation of the nitrate to enter into new combinations. Pure nitrogen is liberated, representing a large proportion of that of the nitrate, the rest forming ammonia, and perhaps amidized derivatives of the organic matter, the liquid being filled with the microbes. Carbolic acid and salicylic acid, in antiseptic, or even larger doses, not only do not hinder the life of the reducing microbe, but themselves disappear completely with the nitrate, in the same way as sugar or propylic alcohol.

Algæ.

Composition of Fucus amylaceus.‡—The chemical analysis of the alga *Sphærococcus lichenoides* Ag., known as *Fucus amylaceus*, has yielded the seven following carbo-hydrates:—

1. *A mucilage soluble in water.* The drug extracted with cold water yields a small quantity of mucilage which is precipitated in alcohol, and is converted into sugar by acids. Mannite and grape-sugar are wanting in the aqueous solution.

2. *A gelatinous non-nitrogenous substance*, with ash amounting to 4·43 per cent.; the analysis yielding C 45·55, H 5·99 per cent., nearly corresponding to the formula 4 $(C_6H_{10}O_5 - H_2O)$. Seven parts in bulk of alcohol produce a precipitate in the hot solution; its solubility in cupric oxide distinguishes it from the lichenin extracted by Berg from *Cetraria islandica;* iodine and H_2SO_4 do not colour it blue; hence it is not a soluble modification of cellulose. This gelatinous substance must not be confounded with the pararabin discovered by Porumbaru in the Japanese Agar Agar. The aqueous solution of the foregoing turns the plane of polarization to the left, and is extremely opalescent.

3. *Starch-flour.*

4. *A pararabin-like substance.* The residue of the *Fucus* was macerated in one per cent. muriatic acid, pressed out, filtered, and the product precipitated with alcohol. The purified precipitate is a white powder containing sulphate of lime. The substance freed from ashes shows the following composition: C 44·78, H 5·95

* Comptes Rendus, xcv. (1882) pp. 644–6.

† Cf. this Journal, iii. (1880) p. 314.

‡ SB. Naturforsch. Ges. Dorpat, vi. (1881) pp. 39–48. See Bot. Centralbl., xi. (1882) pp. 5–6.

per cent., which nearly corresponds to the formula $C_6H_{10}O_5$, and therefore closely resembles Reichardt's *pararabin*, but differs in this, that when boiled with a diluted inorganic acid it yields sugar.

5. *Metarabin.* After a second extraction with dilute hydrochloric acid, the alga being saturated with dilute caustic soda, the filtered solution precipitated with alcohol, and the precipitate purified, its reaction indicates metarabin.

6. *Wood-gum.* Obtained from the residue by the addition of 10 per cent. potash ley. Besides these was also obtained:—

7. *Cellulose.*

All these substances boiled in dilute inorganic acids pass into sugar.

Mazæa, a new genus of Cryptophyceæ.*—A fresh-water alga recently discovered in Brazil, belonging to the group of the Stigonemeæ, has been described by Drs. E. Bornet and A. Grunow, under the name of *Mazœa rivularioides.* This alga, remarkable in various ways, externally resembles *Rivularia plicata* Harv.; its fronds are rounded, more or less irregularly knobby, and attain to a diameter of about 25 mm.; at first solid and somewhat firm, they later become hollow and soft. The colour of moistened specimens is of a sombre green, inclining to olive. The trichomes, immersed in a homogeneous colourless jelly, spread themselves around a central space; they increase towards the periphery, and become lost in the interior. These trichomes give origin to branches, either scattered or unilateral, which elevate themselves to the same height, and to heterocysts either sessile on the side of the cells or borne on a pedicel of one to three cells; intercalary heterocysts were not observed. The heterocysts are oblong in form, easily to be distinguished from the ordinary cells by their size, and above all, by the nature of their contents, which is more homogeneous; when old, they assume a yellowish tint; the chloriodide of zinc colours them purple. When a cell forms a heterocyst or a branch, it first produces a lateral enlargement, which is very early separated. This new cell may at once change into a heterocyst, and then it will be directly applied to the side of the cell, as are the heterocysts of *Capsosira* and those on the large branches of *Stigonema*, or it may be divided once or twice before the formation of the heterocyst, which will be then pedicellated, or it may even form a cell from which a branch may arise. The branches, like the heterocysts, are not uniformly arranged along the length of the filament. At certain spots they are closer and level. Some remain simple, others ramify, none terminate in a hair. No distinct trace of a sheath was observed around any of the younger portions of the trichomes, but at the base the cells are sometimes surrounded with a somewhat thick envelope. None of the specimens (not very numerous) examined showed the least trace of spores or homogonia.

Two characters of this genus are particularly interesting, its rivulariaceous appearance, and its pedicellated heterocysts. This

* Bull. Soc. Bot. France, xxviii. (1881) pp. 287–8 (1 pl.).

latter peculiarity, which hitherto has not been met with among the Cryptophyceæ, indicates in *Mazæa* a degree of specialization of the parts of the trichome greater than that in any other genus of Stigonemaceæ, in fact it represents the highest development in the group. Now that in this genus and in *Capsosira Brebissonii* (= *Stigonema zonotrichioides* Nordst.), Stigonemaceæ have rivularioid representatives, it may be noted that Scytonemaceæ is the only tribe in which this type is wanting.

Resting-spores of Conferva.*—Resting-spores have already been observed by a large number of inquirers in various Confervaceæ; first of all in a *Conferva* first discovered and figured by Itzigsohn, and described by him as *Psichohormium uliginosum*; and again, by Pringsheim, Famintzin, Cornu, and Rosenvinge, in the genera *Ulothrix* and *Conferva*; and they are now found to be present in the whole genus *Conferva* (L.) Wille. N. Wille now adds to these contributions his observations on the manner of forming these resting-spores.

In *Conferva Wittrockii* n. sp. the spore-formation is thus carried on. The chlorophyllaceous contents contract and become rounded. The colouring matter collects principally in the ends of the cells, so that the substance in the middle appears nearly colourless; but after the contraction of the cell-contents the chlorophyllaceous portions of the protoplasm draw nearer together, until at last they coalesce and form a round or elliptical body within the mother-cell; they then begin to surround themselves with a membrane, which later consists of two distinct layers. The spores are generally set free by the filaments resolving themselves into H-shaped cells (in which the cell-wall of each cell has a transverse fissure in the middle of the transverse walls); the spores then fall out. Sometimes they escape by the cell-walls becoming converted into mucilage, their layers becoming gradually indistinguishable. On first germinating, the size of the spores increases, as the result of which the outer membrane bursts. The outer membrane consists of two pieces with pointed ends, one being much larger than the other, and covering it like the lid of a box. Afterwards, through the expansion of the inner membrane, the smaller piece of the outer membrane gives way, and the inner membrane grows through the aperture thus formed in the form of a tube. The development was not followed further, but the writer considers it probable that zoospores are first formed from the resting-spores.

The development in *Conferva stagnorum* Ktz. is of precisely the same character; but here the spores are mostly freed through the conversion into mucilage of the cell-walls. The germination proceeds either as in *C. Wittrockii*, or transverse walls appear in the elongated resting-spores whose outer membrane is not burst, and the young filaments are thus formed. In germination, a sort of organ of attachment is formed by an excretion of mucilage in the pointed end of the spore; or perhaps the mucilage is a local transformation of the outer membrane. In one case the author observed this sort of cell-

* Ofversigt af Kongl. Vetensk.-Akad. Förhandl., xxxviii. (1881), 26 pp. (2 pls.). See Bot. Centralbl., xi. (1882) p. 113.

division in various directions, and considers this phenomenon as the commencement of a palmella-condition.

A third and new species, described as *C. pachyderma*, showed a special peculiarity of the vegetative cells. As a rule the author found imbedded in the transverse walls on each side of the cells, one, and sometimes two, crescent-like particles of cellulose sharply pointed on both sides, which were distinguished from the transverse walls by their more highly refringent power. When the cells are about to transform themselves into resting-spores, they increase somewhat in size, the chlorophyll augments and distributes itself uniformly, but no new membrane appears. It seems as if one, or, perhaps more strictly speaking, two new pointed box-like interlocked layers are formed in the inner, less watery, layer of the mother-cell-wall. The wall of the resting-spore is therefore the thickened wall of the mother-cell. The resting-spores escape through the conversion into mucilage of the outer part of the cell-wall. In germination a hood-shaped piece of the outer membrane of the resting-spore remains, which is attached to the basal cell.

In *Conferva bombycina* Ag. var. *minor*, either single cells swell up into a barrel-shape, or here and there the contiguous ends of two neighbouring cells assume a club-like form. It is here that the largest part of the chlorophyllaceous protoplasm accumulates, and after this the swollen end is separated by a transverse wall from the longer narrow part of the mother-cell. The wall of the swollen part thickens later. The author considers these cells to be resting-spores, although he was not able to observe their germination. *C. bombycina* Ag. var. *genuina* has similar resting-spores.

We find accordingly that three modes of formation of the resting-spores of Confervaceæ have been observed, viz. (1) by rejuvenescence, and the formation of a new membrane round the contracting contents; (2) by the thickening of the membrane of the mother-cell; (3) by separation of a portion of the cell-substance to a swollen part of the mother-cell, and the thickening of the membrane of this portion.

Diatoms of the Baltic.*—H. Juhlin-Dannfelt has critically examined the diatoms of the Baltic, describing over 300 species, including a number of new species and varieties. He finds them to belong entirely to brackish forms, except where fresh water has mixed with the salt, where many true fresh-water species occur. Comparing them with the forms found in the quaternary diatom-beds of Sweden, he finds no identical species, from which he infers a diminution in the amount of salt in the Baltic in historic times.

Motion of Diatoms.—Colonel R. O'Hara writes: "As the subject of the movement of diatoms has been recently brought forward again, the following notes on the subject may be of interest:—

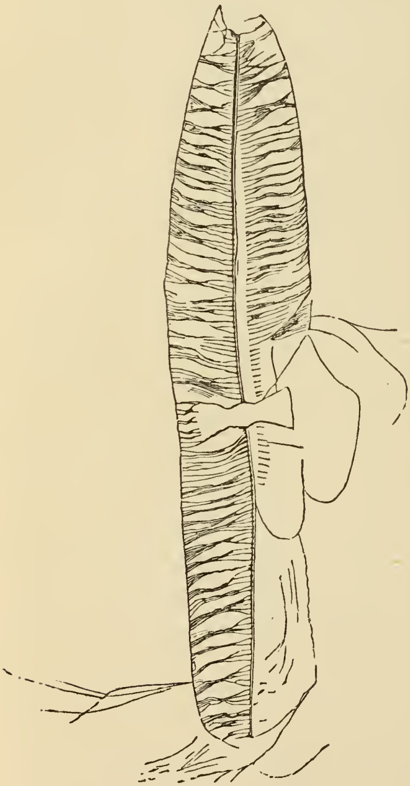
In washing away the acid from diatomaceous material, I have

* Bihang til R. Svenska Vet. Akad. Handlingar, vi. (1882) 52 pp. (4 pls.). See Bot. Centralbl., xi. (1882) p. 153.

constantly observed what appeared to be gelatinous casts of diatoms. In order not to lose these, I have been content to select diatoms from what would be called dirty strewed mixed slides.

In the beginning of 1878, when watching diatoms in their living state, I observed what I thought was a *Cocconeis* moving freely, and there appeared to be an undulating movement along the edge all round. On trying to isolate it I lost it under the cover.

Fig. 147.



In December 1878 I came across what appeared to be a cast of a diatom (*Stauroneis pulchella*), of which I send two photographs* by direct and oblique light. The latter is for the purpose of showing the plasticity of the material more distinctly. It is represented by Fig. 147. The striæ on three-fourths of the figure may be seen to be perfectly distinct and separate along the median line; they then generally coalesce or intertwine, separating again on nearing the edge of the membrane. In the remaining quarter the striæ have apparently coalesced completely, and have formed with the membrane a continuous surface to the point, and beyond. If this be a cast, it strongly suggests movement by cilia or undulating membrane.

It may be said that this is simply an imperfectly siliceous frustule. It must be remembered, however, that the diatom in question had to go through the usual operations of washing, &c. Also why is only one-fourth acted upon up to the median line, whereas in the other three-fourths the finest hair-like (or feather-like) portions are seen distinct at or near the median line, but converging and intertwining towards the delicate membranous looking edge ?

I have also sent two photographs of a *Pinnularia* and cast, by direct light, the one showing what I take to be the siliceous frustule, well defined; the other the so-called cast, well defined,

* The photographs are deposited in the Library.

the focus being altered slightly to take the latter. (In the figure the outer edge of the cast is too hard and defined.) They are represented by Fig. 148. The differences between siliceous frustule and cast are:—In the former, every portion is sharply and hardly defined. There is no appearance of beading; altering the focus

Fig. 148.

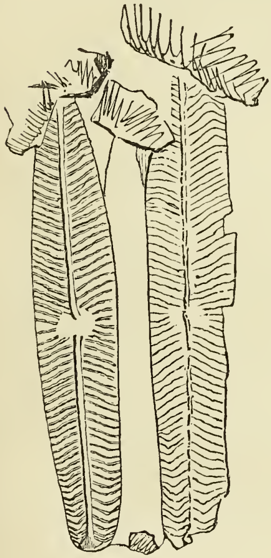
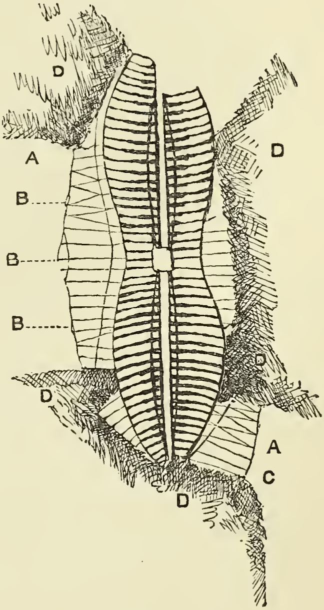


Fig. 149.



brings out shading, and different planes of definition, showing convexity and different curves. In the latter, the median line is very irregular and interrupted, though clearly defined. The striæ are thicker, not hard edged, and show signs of beading. In many places they coalesce. The whole is well defined at the one focus, proving it to be comparatively in one plane.

In the beginning of this year, when examining for selection a mixed strewed (dirty) slide from a gathering, I found a *Navicula* (*Didyma?*), of which I have sent three photographs. It is represented in Fig. 149. Round it there appears to be a double gelatinous membrane, with radial arms extending from the siliceous frustule to the margin of the membrane, where they appear thickened. At A the arms of the lower membrane seem to show through the upper membrane, and form V's with the arms of the latter. They are finer than those arms which appear single, but which I conclude are formed by the arms of one membrane covering those of the other. At B both membranes appear, the edges forming loops. At C the membrane and arms are much extended, the arms

forming the V's being very fine. (D is dirt matter on the slide concealing portions of the membrane.)

From the above and other observations I would suggest that the movement of some diatoms is carried out by means of an undulating and extensible membrane with radiating arms. It would account well for movements as yet unexplainable, as for instance, when a diatom is fixed by one extremity, and has the other end pushed aside by another diatom. When the force so exerted is suddenly removed, the first diatom springs back into the first position, like a bent spring released, as if acting by muscular power.

Having cracked the cover-glass, I am unable now to use an immersion lens, but what I have mentioned is still visible with a good dry $\frac{1}{12}$."

Mr. H. Mills has also detected * in *Stephanodiscus Niagaræ* fine threads twice the diameter of the frustule, as Professor H. L. Smith had previously done in the same object.

Symbiosis of Animals and Algæ.†—In pursuance of his investigations on the symbiosis of certain algæ with the lower animals, G. Entz states that he has been able to detect in the pseudo-chlorophyll-bodies of the infusoria two clear spots which must be regarded as contractile vacuoles. The view previously brought forward that their presence in animal organisms is due to their being taken in with their food is confirmed by the fact that they are scarcely ever found except in the mature individual. Almost the only exception to this is the case of *Hydra viridis*, where they occur in the ova.

With regard to the designation of these organisms as parasites, the term can only be applied to them in a very wide sense, since they can live if removed from their host, which is not the case with true parasites.

Vampyrella and its Allies.‡—J. Klein has continued his observations on the interesting genus *Vampyrella*,§ and furnishes many further details respecting the development of the different species. In *V. variabilis*, he observed that the zoospores sometimes conjugate into a plasmodium even before their escape from the cyst. If the zoospores fail to conjugate, after a considerable time they will put out one or two long slender pseudopodia instead of the much larger number of shorter ones, and by this means effect conjugation with other zoospores.

V. vorax is parasitic upon diatoms, as for example *Synedra;* and in this species the conjugation of the zoospores may be very well observed. They consume the greater part of the contents of the diatom-shell. *V. pendula* occurs on several species of *Œdogonium*, and exhibits essentially the same phenomena as the preceding species. *V. inermis* resembles *pendula* in being parasitic on *Œdogonium*, and

* Amer. Mon. Micr. Journ., iii. (1882) pp. 8–9.
† Biol. Centralbl., ii. (1882) pp. 451–64. Cf. this Journal, *ante*, pp. 241, 542.
‡ Bot. Centralbl., xi. (1882) pp. 187–215, 247–64 (4 pls.).
§ See this Journal, *ante*, p. 544.

in each cyst producing only a single zoospore. It differs in the original cyst-membrane having no spines.

Associated with *Vampyrella*, the author found an allied organism, to which, from its resemblance to *Monas amyli*, he gives the name *Monadopsis vampyrelloides*. It consists of cysts from which zoospores escape in a manner very similar to *Vampyrella*, and Klein believes that it is a transitional stage of development intermediate between this genus and *Monas*.

Respecting the systematic position of *Vampyrella*, the author regards the genus as being most nearly allied to the Myxomycetes, but consisting of forms living in water. The species differ from both the Myxomycetes and the Chytridiaceæ in the absence of a cell-nucleus. They are organisms which are ordinarily propagated non-sexually by means of zoospores; the occasional conjugation of these indicating the commencement of a higher stage. An interesting difference from rhizopods, with which Cienkowski associates them, is that, unlike these low animal forms, they can only derive their nourishment from particular species of algæ. They must, however, be regarded as presenting transitional forms between the animal and vegetable kingdoms.

Special resemblances are pointed out to *Monas amyli* parasitic on *Nitella*, and to *Protomyxa* and *Myxastrum* which inhabit sea-water—all of which produce conjugating zoospores. Klein regards them as intermediate forms between *Vampyrella* and the true Myxomycetes; while *Nuclearia* and *Actinophrys* are the most nearly allied forms among rhizopods.

He proposes to establish a new family of Hydromyxaceæ, with the following characters:—Parasitic aquatic organisms, producing cysts, from which, when mature, one or more zoospores destitute of nucleus escape directly. At once, or at a later period, these assume an actinophrys or amœboid form, two or more coalescing with one another when meeting, and producing plasmodium-like bodies. The zoospores, as well as the plasmodia which result from their coalescence, form new cysts after absorbing nutriment. Subsequently, also, resting cysts are produced; but these are not at present known in *Monadopsis* and *Protomyxa*. The family is made up of the genera *Vampyrella*, *Monadopsis*, *Monas*, and *Protomyxa*. The following are the generic characters:—

1. *Vampyrella* Cnk. The ripe cysts contain a red or orange endochrome, with dark spots; membrane usually coloured blue by iodine and sulphuric acid. The endochrome escapes in from 2–4 (rarely more) pieces, which develope into zoospores, moving either by pseudopodia or by a colourless seam; the division into zoospores takes place during the escape. In the coalescence of the zoospores, the pseudopodia first unite, and then the body; from 2–4 (rarely more) zoospores conjugating in this way. Plasmodia small, usually resembling a large zoospore, and with neither vacuoles nor anastomoses. The plasmodia and zoospores both develope into new cysts. Resting cysts are also known. Seven species.

2. *Monadopsis* Klein (only 1 species, *M. vampyrelloides*). Cysts

small; endochrome pale red; membrane delicate, coloured blue by iodine and sulphuric acid. Endochrome escapes simultaneously in two or three portions; the division taking place before the commencement of the escape. Zoospores very small, of irregular amœboid appearance, with only a few short pointed pseudopodia. In conjugating the zoospores envelope the isolated cells of the host (unicellular algæ), forming a new cyst round them, or several individuals are thus enveloped. Resting cysts unknown.

3. *Monas* Cnk. (only 1 species, *Monas amyli*, or *Protomonas* Haeck.). Cysts spherical, with simple thin membrane and colourless endochrome, from which a number of zoospores are formed. Zoospores, at first fusiform and bi-ciliated, with serpentine motion, afterwards amœboid or actinophrys-like, with several fine pointed pseudopodia and slow movements, during which they change their form. Small plasmodia formed from the coalescence of several amœboid zoospores. The hosts (grains of starch) are surrounded by the zoospores or plasmodia, thus forming a new cyst; several zoospores often coalesce on the same starch-grain. Resting cysts formed by the ordinary cysts throwing off the unconsumed nutrient material, and enveloping themselves with a new membrane, wart-like projections appearing on the inner side of the original membrane.

4. *Protomyxa* Haeck. (only 1 species, *P. aurantiaca*). Cysts spherical, with moderately thick membrane, structureless, and not coloured blue by iodine and sulphuric acid. The fine-grained orange-red endochrome breaks up into a number of portions, each of which escapes as a zoospore. Zoospores pear-shaped, with a single cilium at the narrow end, and slow motion, subsequently amœboid and protean. Large plasmodia formed by the coalescence of several amœboid zoospores, furnished with branched anastomosing pseudopodia and vacuoles. The hosts (various diatoms) are surrounded by the amœboid zoospores or plasmodia, and their shells thrown out after their contents have been absorbed; a new cyst is thus formed, a new membrane being excreted. Resting cysts unknown.

MICROSCOPY.

α. Instruments, Accessories, &c.

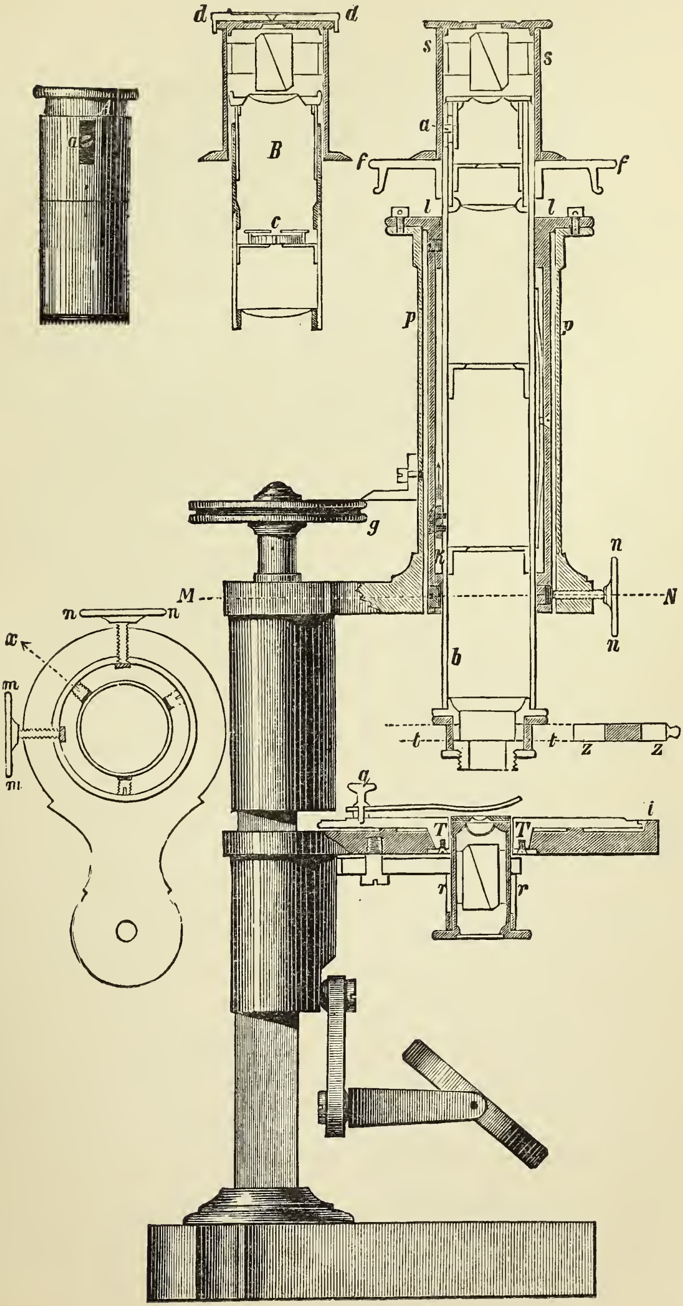
Petrographical, Mineralogical, or Lithological Microscopes.—Rosenbusch, Fuess, Beck, Swift, &c.—(1) *Rosenbusch's Petrographical Microscope.*—Special Microscopes for the examination of minerals and rocks are now supplied by nearly every optician. The original of such instruments * is the one devised by Professor Rosenbusch, in 1876,† which is illustrated in Fig. 150, with a few modifications introduced in its manufacture by R. Fuess, of Berlin.‡

* A "Mineralogical Microscope" was described by S. Highley in Quart. Journ. Micr. Sci., iv. (1856) pp. 281–6 (3 figs.).

† Neues Jahrbuch f. Mineral., 1876, p. 504.

‡ Cf. Loewenherz, L., 'Bericht über die Wiss. Instrumente auf der Berliner Gewerbeausstellung im Jahre 1879,' pp. 282–6 (1 fig.), pp. 350–3 (1 fig.).

Fig. 150.



The chief advantages of the instrument consist*:—(1) In the facilities for turning an object in its own plane between fixed crossed nicols, the rotation being concentric with the axis of vision; (2) In the ability to read off accurately the angle through which the object may be turned in a horizontal plane by means of the graduation round the circular stage; (3) In the facility with which the polarizer and analyzer can be displaced and replaced, and the means by which the exact position of the principal sections of the polarizer and analyzer can be noted; (4) Where the total extinction of light by means of crossed nicols interferes with the researches on any mineral, means are provided for facilitating observation under such circumstances.

The peculiarities in the construction of the Microscope consist in the tube which carries the eye-piece and objective *b* (Fig. 150), being as it were suspended within an outer tube *p*, its only attachment being at the top at *l*. A block *k* is fixed between the inner and outer tubes to prevent any rotation during focal adjustment. The coarse adjustment is effected by hand, the thumb and forefinger sliding the inner tube up and down by pressure on the disk *f*, other fingers being applied to the top *l*, of the fixed tube. The fine adjustment consists of a micrometer screw, shown at *g*, graduated in 500 divisions, each being equal to 1 μ. The unattached portion of the inner tube is steadied in the outer one by means of a spring † and three little screws *x* (see side figure, a section through M—N), set horizontally and capped with scraps of parchment, which are more or less compressed as the adjustment is made. The arm of the Microscope carries two screws with milled heads, one of which is shown at *n*, and both at *n* and *m* in the side figure. These are set at right angles to one another, and serve to centre the tube. The eye-piece carries two cobwebs, which intersect at right angles in the centre of the field. To the outside tube of the eye-piece a small peg *a* is fixed, which slides into a corresponding slot in the top of the inner movable tube of the Microscope. This arrangement prevents any rotation of the eye-pieces, and so keeps the cobwebs in a fixed position. An analyzer *s*, fitting in a brass cap, slides over the top of the eye-piece. The bottom of the cap is surrounded by a bevelled flange, which is graduated to 5°. An index mark on the plate *f*, serves to record the angle through which the prism is rotated. The stage of the Microscope is circular, and a circular plate T is arranged so as to revolve horizontally on it. This plate is graduated on its margin, and an index to record the amount of the revolution is attached to the front of the fixed stage at *i*. It also has a spring clip *q*, and a Wright's indicator (two scales at right angles). Beneath the stage is set an easily displaceable polarizer *r*, consisting of a Nicol prism, which revolves within its external tube by means of the lower disk, which is graduated to 10°, and has its index marked on the fixed outer tube. This polarizer does not turn when the stage plate is rotated, but

* See Rutley's 'Study of Rocks' (8vo, London, 1879) p. 54.
† In the figure, in order to show the spring, it is brought too far round by 45°.

remains unaltered in position. A plate of quartz for circular polarization 3·75 mm. thick, and mounted in a little brass fitting, is shown at *z*. It slides into a slot *t*, situated close to the lower end of the inner microscope-tube and above the objective. The movement imparted to the microscope-tube by the screws *n m*, tends to throw the analyzer slightly out of position with regard to the polarizer, but Professor Rosenbusch finds that this produces scarcely any appreciable error.

For very strongly convergent light, the ordinary condensing lens (with a focus of 12 mm.) attached to the Nicol, is combined with a second one of only 8 mm. The axes to these mineral sections can thus be recognized without an eye-piece and with the objective alone.*

The stauroscopic eye-piece is shown in the side diagrams A and B of Fig. 150. The eye-lens is attached to a separate tube sliding in that holding the field-glass, and can be brought closer to the latter. The tube of the field-glass has a slit in which a pin *a*, inserted in the eye-lens tube, slides. The pin also passes into a slit in the microscope-tube, and thus fixes the position of the eye-piece. At *c* is a plate of calc-spar in the focus of the eye-lens. This was first used by Professor Calderon for stauroscopic measurement, and afterwards adapted to the Microscope by Fuess. For the purpose of accurately indicating to the eye the correct position with regard to the optical axis of the instrument, a cap with a very narrow diaphragm *d* is added, there being another diaphragm at *c*.

Professor Rosenbusch points out that the use of this Microscope is not confined to the purpose for which it was designed, but that it is also available for other microscopical purposes where exact measurements are required.†

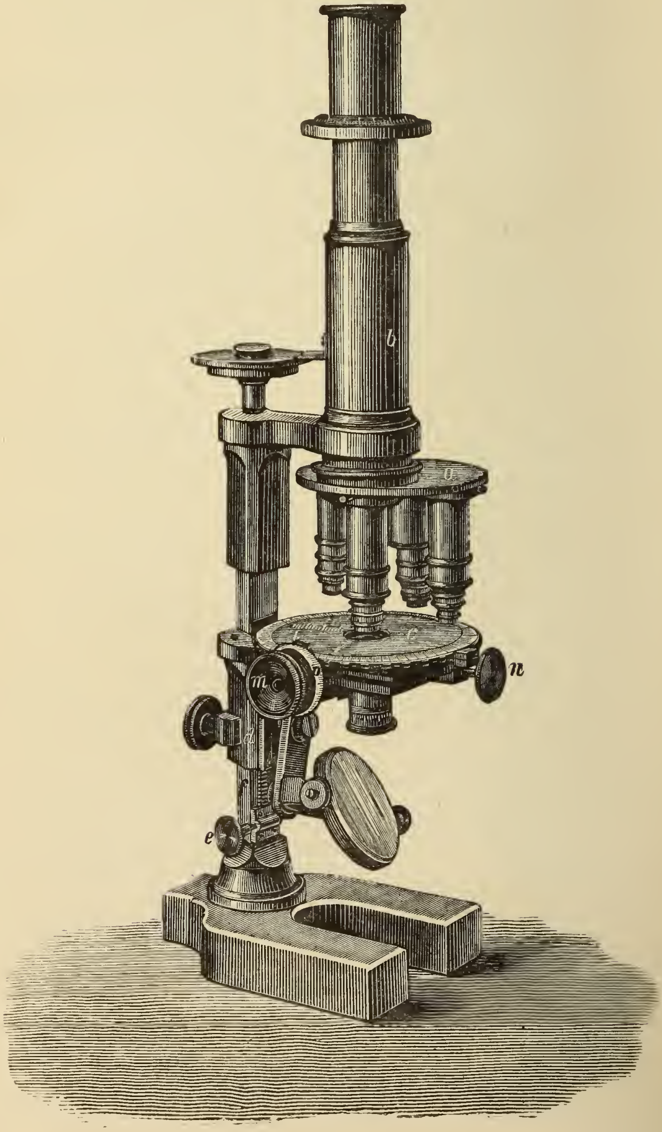
(2) *Fuess's "large Microscope for mineralogical and petrographical observations"* (Fig. 151), is designed as an improvement upon the preceding, especially as regards the stability of the centering arrangement. The sliding coarse adjustment is done away with, and instead of it, the stage *c* with the illuminating apparatus is attached to the slide *d* which moves on the upright support *f* of the stand to a distance of about 1·5 cm. (by means of the rack-work attached to *d* and actuated by the pinion *e*), and is held in the required position by the clamping screw behind. The fine adjustment is effected by the usual graduated micrometer screw. By the use of intermediate pieces of tubing the objectives can be so attached to a horizontal revolving plate *a*, that they all stand at about their focal distance from the object if the slide is of ordinary thickness. The centering of each objective with the optic axis of the tube *b* is then effected by three adjusting-screws below the revolving-plate, so that the arrangement

* See this Journal, i. (1878) p. 207.

† The graduation of the micrometer-screw and the addition of the plate of calc-spar and the Wright's indicator, appears to have been suggested by Professor A. v. Lasaulx. Cf. Bull. Soc. Belg. Micr., iv. (1878) p. clxxvi. The Microscope described by M. Renard, Bull. Soc. Belg. Micr., iv. (1878) ccxv., and this Journal, i. (1878) p. 270, appears to have been a Rosenbusch-Fuess instrument, but with the Lasaulx improvements and the addition of the quartz plate.

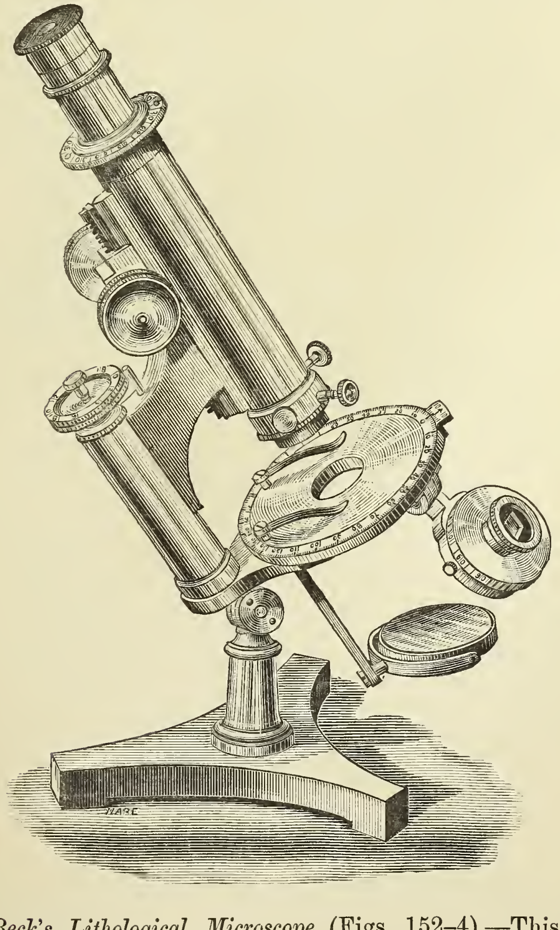
at the lower end of the tube of the Rosenbusch instrument is unnecessary. The diaphragm and polarizer can also be centered by means of the rectangular stage movements actuated by the milled

Fig. 151.



heads *m* and *n*. The former movement is made to do duty as a screw-micrometer, having a drum *p* attached, engraved with 125 divisions, each having the value of 0·002 mm., the screw pitch being 0·25 mm. The revolutions of the screw can be read off on an index *i*. The margin of the stage is graduated and also dentated, so that it can be turned by the finger. For convergent light, two Bertrand lenses of 12 and 8 mm. focal length are placed above the polarizer, and a third above the objective.*

Fig. 152.



(3) *Beck's Lithological Microscope* (Figs. 152–4).—This instrument (Fig. 152) is modelled on the plan of the "Economic" Micro-

* Cf. this Journal, i. (1878) p. 292.

scope with the alterations necessary to fit it for lithological examinations. The coarse adjustment is effected by the usual rack-and-pinion, and the fine by a micrometer-screw with a divided milled head, representing thousandths of an inch, for the approximate measurement of sections, &c. The stage is divided on the edge to degrees, and has a vernier reading to 10′, adapting it for use as a goniometer or for stauroscopic measurements, &c. It rotates concentrically with the optic axis, and to compensate for any slight variation in centering there is a centering nose-piece. Immediately above the latter is a Klein's quartz plate fixed on an arm by means of which it can be

Fig. 153.

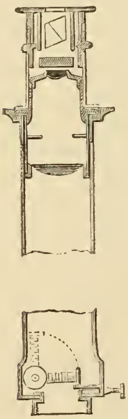
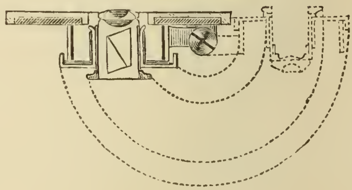


Fig. 154.



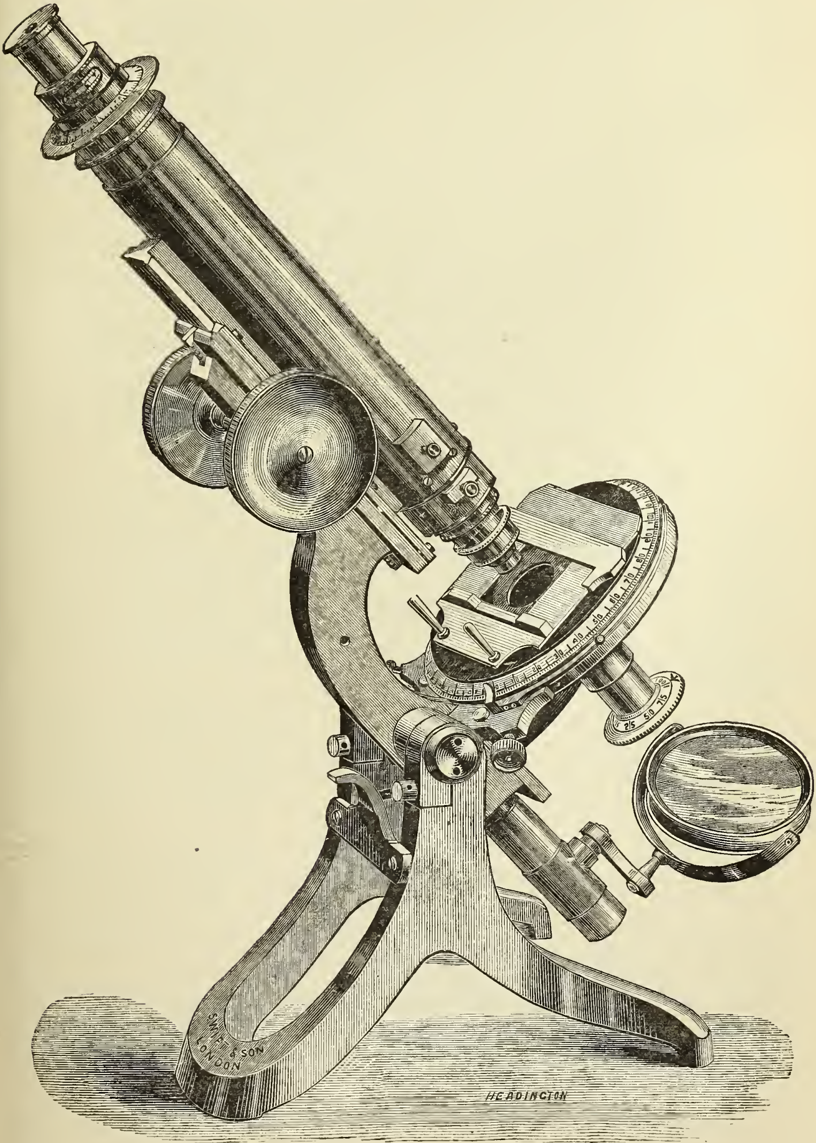
turned up out of the field with great facility as shown in Fig. 153. One of the three milled heads at the end of the body-tube effects this movement. The other two milled heads are for centering the objective, and their action is shown in the same figure.

The analyzer rotates freely over the eye-piece (Fig. 153), and has an index which by a divided plate on the draw-tube allows it to be read in any position and recorded. Between the analyzer and the eye-piece is placed a plate of calc-spar cut at right angles to the optic axis for stauroscopic measurements. The eye-piece has cross cobwebs. The rotating polarizer also has a divided circle to register its position, and it is fitted into a swinging arc which is in contact with the bottom of the stage, thus excluding any false light. By means of a hinge it can be instantly turned away from the stage (in the way shown in Fig. 154) when ordinary illumination is required. A condenser of large aperture, fitting into the tube of the polarizer above the prism, is intended for the examination of the interference brushes and rings in crystals with convergent light. This also is easily removed when not required. When the instrument is used for this purpose a lens is screwed into the lower end of the draw-tube.

The instrument, though specially constructed for the study of rock sections, can be used for any other work. It is only necessary to remove the analyzer and polarizer. The fitting on the swinging arm which carries the polarizer will take any other substage apparatus such as parabola, achromatic condenser, &c.

(4) *Swift's Petrological Microscope* (Fig. 155).—The general basis of this is Mr. Swift's well-known "Challenge" stand (see Vol. I. (1881) p. 810). A special arm carrying the polarizer is added so that it can

FIG. 155.



be readily turned away when not required, and a tube inserted in its place for sub-stage apparatus. The fitting of the polarizer is graduated and a spring catch indicates when the prisms are crossed. The rotating glass stage is graduated, and has a "self-centering" arrangement. Two sliding boxes at the lower end of the body-tube serve to carry the analyzer and, below it, a Klein's quartz plate, which can thus be readily slipped in and out. An extra analyzing prism with divided circle is placed over the eye-piece (which has crossed spider-lines) with a contrivance for rotating crystals between it and the prism.

There is also a new arrangement for showing the rings in biaxial crystals of extreme wide angle, diopside for instance, with its entire system of rings being (it is claimed) "exhibited as large and with greater brilliancy than with Nörremberg's Polariscope." For this purpose an achromatic lens is interposed by means of a supplementary draw-tube between the eye-piece and objective, an optical combination of large aperture being fixed over the polarizer.

Mr. Bulloch, of Chicago, has also issued a Microscope for the study of rock sections, adapting for the purpose the model shown in Fig. 140 of Vol. III. (1880) p. 1077. Cf. also Rutley's, Vol. II. (1879) p. 470, Nachet's Petrographical Microscope, Vol. III. (1880) p. 227, and Vérick's Goniometrical Microscope for Mineralogy, Vol. I. (1881) p. 812.

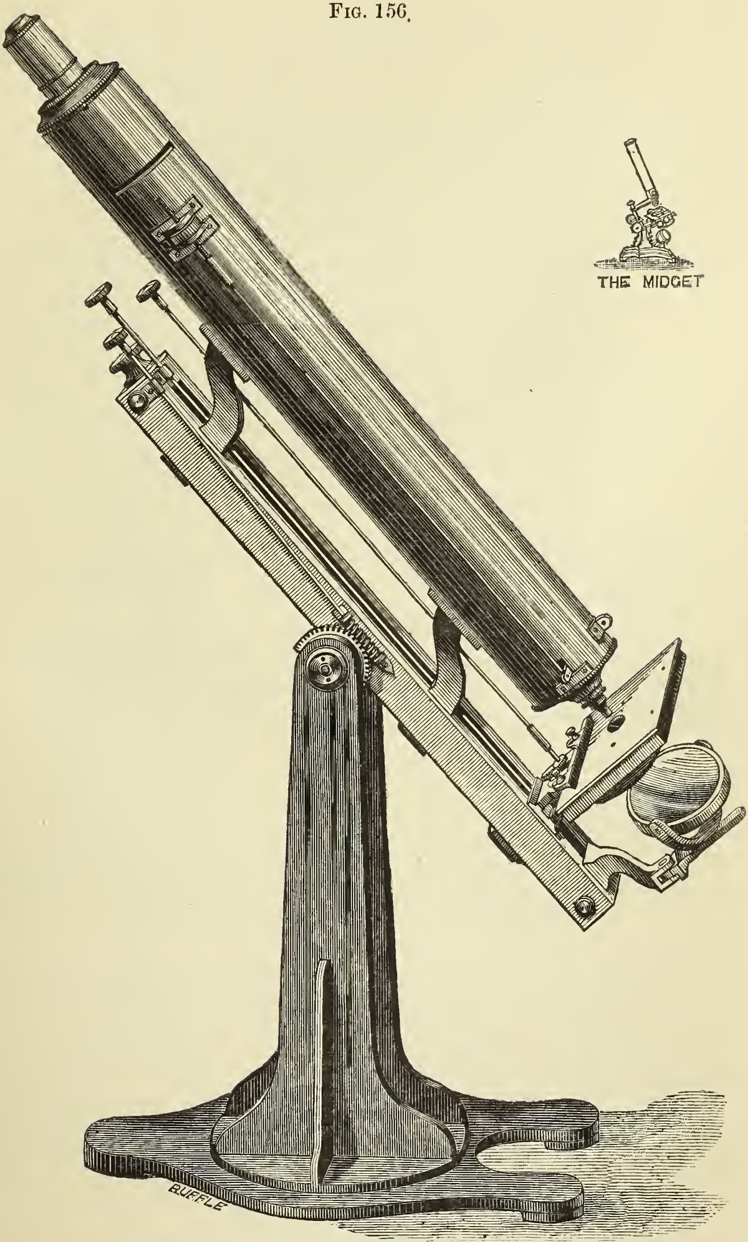
"Jumbo" Microscope.—The instrument, from Mr. Crisp's collection, shown in Fig. 156 (about $\frac{1}{8}$ nat. size) is another of the numerous instances of misdirected ingenuity in the designing of Microscopes. It was made in 1851 by G. Lowden, junr., a Dundee optician, for a gentleman then lately returned from India. It stands 4 feet high, weighs $1\frac{1}{2}$ cwt., and the body-tube is 4 inches in diameter. It is therefore entitled to the distinction of being the largest and heaviest Microscope made within modern times!*

For the coarse adjustment the stage is moved up and down along the bar which supports the body-tube, its movement being controlled by the large milled head on the upper end of the bar. The fine adjustment is worked by the milled head and rod attached to the body-tube, by which an inner tube carrying the objective is raised or lowered.

As the stage is so far from the observer its movements are effected by the two longer rods terminating in milled heads shown in the figure above the end of the bar. One of these moves the stage from back to front, the other turning it to either side on a pivot at its base, giving it therefore a movement in a segment of a circle. The remaining shorter rod has a screw at its lower end which, working in a toothed wheel on the axis, causes the body of the instrument to incline as may be desired. The eye-piece is pierced with a slit to admit a slide holding prepared paper for "calotyping" an object by the old paper process.

* Schott, 'Magia Universalis,' 1677, describes and figures Microscopes of enormous size.

Fig. 156.



THE JUMBO.

"Midget" Microscope.—Fig. 156 also shows this Microscope to the same scale as the previous one. It was made by Mr. S. Holmes, and is only $4\frac{3}{4}$ inches high with a diameter of body-tube of less than $\frac{1}{2}$ inch. It is probably the smallest working instrument ever made.

Beck's Histological Dissecting Microscope.—This instrument (Figs. 157, 158) combines a compound with a simple and dissecting Microscope, the stout arm holding the single lenses being made so that a compound body (fitted with "Society" screw) can be substituted. A speciality consists in the adjustment of the mirror, which can be used as in Fig. 158 for transparent objects, or can be brought above the stage as in Fig. 157 for opaque ones.

Fig. 157.

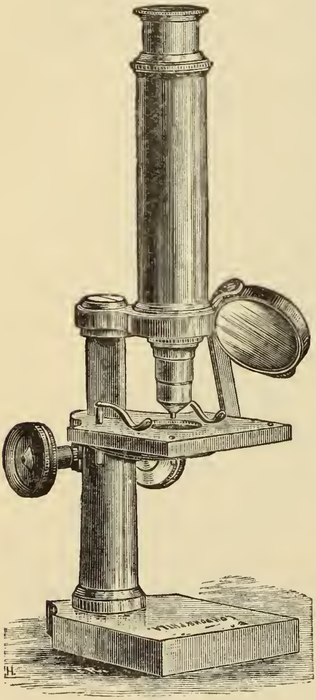
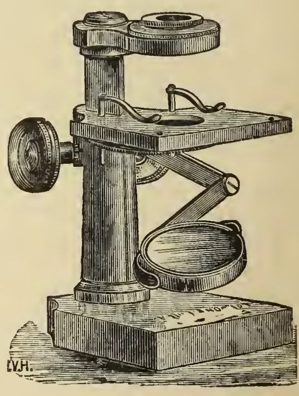


Fig. 158.



Gundlach's Globe Lens.*—This is a perfect sphere, consisting of a hollow flint-glass globe, made in halves, and enclosing a solid crown-glass globe. It is said to be constructed "according to a new optical principle discovered by Gundlach. By this principle the aberrations are corrected to a higher degree than has heretofore been attained by any other construction. The lens has an optical axis in any direction, hence the field is perfectly flat and distinct to the outer edges; and what is true of no other lens, the field is always the largest possible."

There are five sizes, 1, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{3}{8}$, and $\frac{1}{4}$ inch.

* 'Descriptive Price List of Gundlach's New and Improved Objectives,' March 1882, p. 8.

Designation of Eye-pieces.*—At the Elmira meeting of the American Society of Microscopists, Dr. R. H. Ward, the chairman of the committee on eye-pieces (*ante*, p. 103), reported, that "all manufacturers but one had agreed to designate their eye-pieces by their focal-lengths, but no agreement had yet been made as to the diameter of the tubes." The committee was continued for another year.

Objectives of small and large Aperture.†—The Rev. W. H. Dallinger writes on this subject as follows:—"No one has appreciated or found more pleasure and profit in the use of the large angles with which our lenses have been more and more perfectly provided for the last ten or twelve years than I have. As they have been produced I have obtained them each and all, that had any real value, whether produced in this country, the Continent, or America, and in some cases I have incited certain English makers to produce certain special formulæ during that time. But while I have used all lenses, from the $\frac{1}{4}$ to the $\frac{1}{50}$, constantly during this time, what work I have done could never have been accomplished if I had *only* had lenses with *large angles* to work with. Much that had been done could never have been done *without them;* but the work, as a whole, could never have been done at all if only such had been at my disposal. Hence I have, in all my special working powers, *three* lenses of the same power, and in some cases four, and *each* of them, in following out the details of a life-history of an organism, say of the $\frac{1}{3000}$ to the $\frac{1}{6000}$ of an inch in length, is absolutely needed, and its place cannot be supplied by the other. Thus, I have two $\frac{1}{50}$ths, one having a very low angle, and the other as great a numerical aperture as an oil-immersion can provide when worked by the best makers. In the $\frac{1}{35}$th, I have but one lens, a medium angle, because it was intended only for general work and, mainly, central illumination. I have, however, three $\frac{1}{25}$ths, four $\frac{1}{16}$ths, and so on; and I know exactly what each will do, and no more attempt to get the work of one out of the other than the maker of them would attempt to get their several results by grinding them to the same formulæ.

I talked this matter over in detail, pointing out results, six years ago with some leading experts; and although, during two or three years, many have thought that Abbe's mathematics and views were adverse to this view of mine, I felt convinced by reading between the lines of his papers, and remembering their special object, that it was not so. Still Dr. Carpenter was good enough to get a detailed view of my experience and opinion before publishing the last edition of 'The Microscope,' and he has in his preface and throughout the volume, given in effect my views, which now the unmistakable declarations of Abbe coincide with and confirm. The homogeneous lenses have given me splendid results, some of which will shortly be published; but *no* immersion lens of *any* kind *could* be used to work out to the end an organic life-history—that is, if it involved life and movement, because the object being in a limited area, and possibly in fluid, the fluid *under* the cover does (when the movements of

* Amer. Mon. Micr. Journ., iii. (1882) pp. 175 and 171.
† North. Microscopist, ii. (1882) pp. 288–9.

the object are followed) at length, without the spectator's knowledge, mingle with the fluid *above* employed for the lens, and thus destroy the whole object of search and study. This fact, then, makes air angles of the highest importance, and I hope the highest results have not yet been attained with them. In the main, then, I agree with Abbe."

At the Montreal Meeting of the American Association for the Advancement of Science, Dr. W. B. Carpenter gave an address on the practical and theoretical results in the history of the Microscope, in which he dwelt mainly upon the question of wide aperture and high power eye-pieces.

Correction-adjustment for Homogeneous-immersion Objectives.* Dr. L. Dippel has already briefly published his objections to the use of a correction-collar in the case of homogeneous-immersion objectives (in opposition to the contrary opinion of Dr. H. Van Heurck) which he considers to be an abandonment of the practically most important advantage for scientific work which homogeneous-immersion has brought us, but is now led to return to the subject by the recent publication of the views of Dr. G. E. Blackham † (also of Dr. J. Edwards Smith ‡), in favour of the retention of the correction-collar, and he accordingly discusses the subject in some detail.

If we consider the matter first from the side of theory, it must on the one hand be allowed that the correction-collar, from a purely theoretical point of view, may have certain (though as will be seen in the sequel practically unimportant) advantages, while on the other hand it is undoubtedly the fact that the other advantages ascribed to it must be regarded as imaginary.

The advantages relate essentially to the following points:—First, with the correction-collar we are not so strictly limited to an immersion fluid of a particular index of refraction, as we are in the case of the fixed mounting, but various fluids can be used, which are different within certain—though always very narrow—limits.

In the use of an immersion fluid not precisely of the same refractive index as crown glass (which is the case with most of the immersion fluids hitherto employed, except the thickened cedar-wood oil), we can still obtain perfect correction for cover-glasses of varying thickness.

Further, those aberrations (comparatively considerable) can be corrected, which occur with dry preparations (rarely, however, coming under consideration in the scientific use of homogeneous immersion), if they do not adhere closely to the slide, but are separated from it by a thin stratum of air.

Finally, the correction-collar allows the same objective to be used with a longer or shorter tube, while otherwise one is confined to somewhat narrow limits in the length.

All the other advantages, however, urged by the advocates of the correction-collar are only imaginary, such as the possibility of most exact correction for the change in the index of refraction of a par-

* Zeitschr. f. Instrumentenk., ii. (1882) pp. 269–74.
† Cf. this Journal, *ante*, p. 407.
‡ 'How to See with the Microscope,' 1881.

ticular immersion fluid, in consequence of variations in temperature; or of an alteration in the optical properties of the cover-glasses, and the different powers of accommodation of the eyes of different observers.

The author has already shown* the practical insignificance of the difference in the refractive index of the immersion fluid produced by the varying temperature of the observing room in the ordinary use of the objectives in question, where the changes of temperature cannot be very important. Theoretically considered also, the matter will be seen to be of only little moment. According to the measurements of Professor Abbe, the difference with cedar oil is but 0·003 for a variation in temperature of 3° C. Since the correction of the objectives is arranged for a medium temperature of from 18° to 20° C., and the temperature at which normal microscopical observations are made is certainly (even if we allow very wide limits) between 15° and 28° C., the greatest deviation from the mean value in the refractive index is at most two or three units in the third decimal place. The aberrations in the divergence of the incident rays connected with this slight change and the consequent disturbance of the spherical correction, whilst it can be demonstrated by *very accurate* testing on the silver plate, is nevertheless in any case much smaller than those deviations from the *best* correction which occur with the correction-collar. It therefore follows that this much enforced deviation in the refractive index of the immersion fluid, caused by variations of temperature, which is to be balanced by the correction-collar, is at all events the *lesser* of two evils, and consequently can furnish no pretence for doing away with the fixed mounting.

Still less than the above-mentioned variations can the differences in the refractive index of different cover-glasses give any inducement for the introduction of the correction-collar. According to the observations of Professor Abbe during a period of ten years, these differences are so extremely small that they may be regarded practically as nil.

Finally, the suggested influence of the different powers of accommodation of the eye must be relegated to the region of dreams, as a simple theoretical consideration will show. If we take for example a power of 800, and two observers whose eyes are accommodated respectively to 100 mm. and an infinite distance, the difference in the adjustment thus produced—that is in the actual object-distance, assuming the objective to have air on both sides of it—can be easily computed from the formula :—

$$x\,x^* = -f^2.$$

For a long-sighted eye (where $x^* = \infty$)

$$x = 0.$$

For a distance of vision of 100 mm. (where $x^* = -100$) $x = \frac{f^2}{100}$, and since in the Microscope as a whole $f = \frac{250}{N}$,

$$\therefore x = \left(\frac{250}{N}\right)^2 \cdot \frac{1}{100}.$$

* Bot. Centralbl., No. 6.

Consequently, in the case assumed above of a power (N) of 800, x is rather more than 0·0009 mm. (or 0·9 μ), or if the object is in a medium of $n = 1 \cdot 50$, not quite 1·5 μ. This exceedingly slight displacement of the focus forms the measure of the alteration in the path of the rays in the objective, and it is the aberration which corresponds to the difference in the visual distance, assuming that accurate correction is first made for $x = 0$: much less if the largest possible aperture is assumed for that x, and generally not ascertainable, since it depends, like the moving of the lenses towards each other (by the correction-collar) upon the particular construction of the objective. Let us, however, assume that this movement of the lenses which is necessary for the equalization of the very slight difference in the path of the rays corresponding with the above ascertained difference of adjustment (and of the consequent disturbance of the spherical correction), amounts to even 0·1 μ, or 0·0001 mm., which is certainly *far too high*, this would still be a quantity which is unattainable by any *mechanical contrivance*, least of all by such a mechanism as the correction-collar. If Dr. J. Edwards Smith adduces against the results thus established by theory, a case in which three divisions on the scale of the correction-screw would be required for the equalization of the difference between the power of accommodation of his own eye and that of another observer (Mr. C. Spencer), it must be said that such a thing is entirely absurd. It proves in fact simply that what he regarded as the action of different powers of accommodation, was nothing more than an effect of "personal equation" in the judgment of the best image, and therefore rests entirely on purely subjective opinions.

If we now further examine the matter from a practical point of view, it may be at once allowed that the *technical* considerations against the correction-collar are not so weighty that it should be set aside on that account if *really practical* advantages were to be gained by it. For even if the greatest perfection of centering (such as is possible with the fixed mounting) cannot be obtained with the correction-collar nor its durability guaranteed, yet according to the examination by Professor Abbe of the correction-objectives of Powell and Lealand and Zeiss, a sufficient amount of accuracy can be obtained by very careful work. The question of expense, which the author previously laid stress on, need not be considered, because, as Professor Abbe observes, the technical difficulties in mounting the fixed objectives (on account of the final adjustment of the distances of the lenses to fractions of a hundredth part of a millimetre), are not less than in those with the correction-collar, and therefore the price for both kinds is about equal. In this respect, therefore, there is nothing to urge against the introduction of the correction-collar.

Now, however, the question arises, how and to what extent the *possible* advantages suggested by theory can be realized in practice without prejudicing the usefulness of the objectives, and on this point the author is strongly convinced that in the proper scientific use of the Microscope for the examination of *unknown objects and structural*

elements, the advantage to be expected by the use of the correction-collar is not only absolutely *illusory*, but that it is attended with many serious disadvantages.

In the observation of diatoms, which one has seen so often, and the structure of which is so simple and characteristic, it is not a matter of great difficulty to find *approximately* the best correction by experiment, since one forms a judgment from the clearness and distinctness of the image. For those, therefore, who study preferably the structure of diatoms, or who have set themselves the task of demonstrating test-objects a number of times (from whom has originated the desire for this contrivance), the correction-collar may prove of some slight advantage in the sharpness of the image, and for that reason may appear to be a desirable requisite. For this class of observation it may be readily admitted that at least no important disadvantage can arise.

For histologists, however, the case is very different. With the objects that come under their observation, especially if they are of very delicate and complicated structure, it is almost impossible to find the best correction by mere trial. In endeavouring to find the "best image" we are just as likely to arrive at a completely *false* correction (which produces *false* images) as upon the proper one. The widest latitude is thereby given to every possible subjective fancy and false arbitrary interpretation, and those deviations from the best correction which still remain, in the in other respects skilful use of objectives with fixed mounting and carefully corrected for a given length of the tube and a particular immersion fluid, are perfectly insignificant and harmless as compared with the great uncertainty and grave aberrations which the use of the correction-collar introduces.

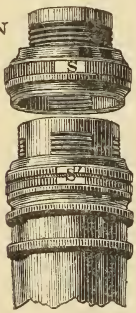
If the best correction for a certain thickness of cover-glass is required, there is only *one* object by means of which this can be obtained with perfect certainty and with the smallest amount of subjective fancy, so that correct images of all objects of any structure can be guaranteed (without false differences in level, &c.). This object is the Abbe test-plate, by which the correct co-operation of all zones of the aperture can be judged of. That, in comparison with this plate, the structures of the valves of the Diatomaceæ are by no means sufficient, is best proved by the case brought forward by Dr. Edwards Smith, in which personal equation evidently played no unimportant part. And if even in the case of such an object—striæ of diatoms of well-known nature—such latitude was given for the exercise of personal caprice in the adjustment of the correction-screw for the "best image," how great may it be when we are dealing with *unknown* delicate and complicated structures? Under such circumstances, how easily may the employment of the correction-collar become rather a subject of misuse than of use? With high power dry objectives and water-immersion objectives the correction-collar is a necessary evil which must be endured. Where, however, it can be dispensed with, it would be folly to retain it on account of entirely subordinate and unimportant advantages. Especially may it be *very decidedly rejected* in all scientific work with homogeneous-immersion objectives. The slight restriction in the use of objectives with fixed mounting can the

more be endured, since on the one hand each of such objectives can be adjusted according to desire for the short Continental or for the long English tube, and thus effect can be given to personal inclinations; while on the other hand, where it is a question of *sharpest* observation, it is easy to provide a suitable medium thickness of cover-glass where the immersion fluid is not exactly uniform with crown-glass. Under all circumstances one gives up in using the fixed mounting only *unessential* conveniences and benefits hardly worth consideration, whilst far greater advantages are gained and very considerable defects avoided.

In conclusion, therefore, Dr. Dippel repeats:—"For all histological and similar scientific observations, hold firmly to the fixed mounting for homogeneous-immersion objectives. And if we have such an objective with correction-collar, I say with Prof. Abbe, 'after careful testing of the best correction for *medium conditions* by means of the silver plate, screw it up *tightly* ("niet und nagelfest," clinched and riveted), so that no mischief can arise.'"*

Nelson's Adapter for Rapidly Changing Objectives.—This appliance has been devised by Mr. E. M. Nelson to facilitate the rapid interchange of objectives without the necessity of triple or quadruple nose-pieces, or such an alteration of the existing system as would prevent the free interchange of objectives provided with the normal Society screw, as is the case with the devices of Parkes, Nachet, and Vérick.

Fig. 159.



In Fig. 159 N is an adapter,† the inner screw-thread of which is filed down smooth in three equal and equidistant segments, leaving the thread intact in the intervening three segments. The screw-thread on the objective is filed down in three places to correspond with N, so that where the gauge-slots S and S′ coincide the objective can be pushed in for the length of the screw, and then an eighth of a turn to the right screws it securely "home," just as it would be after the four turns required with the Society screw and ordinary nose-piece. Similarly to detach it, only an eighth of a turn to the left is necessary. Whilst the objective can be inserted at any of the three positions in which the segments of the nose-piece and objective coincide, it is only in the one position where the gauge-slots S and S′ coincide, that the screw-threads correspond, and the one-eighth turn for screwing "home" can be made without injury to the threads.‡

* Cf. the discussion on this paper, Proceedings, *post*.

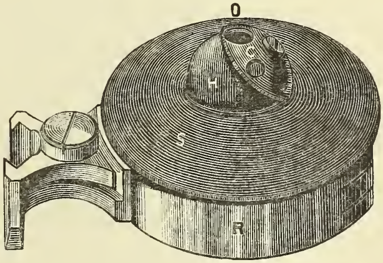
† By a mistake of the engraver the outer screw of N is drawn of less diameter than that of O. They are both of Society gauge.

‡ Since the construction of the adapter, Mr. Nelson's attention has been called to a communication in 'Science-Gossip,' 1879, p. 18, in which Mr. James Vogan suggested a similar system under the heading "A Substitute for Nose-pieces." The plan then proposed by Mr. Vogan involved cutting away two segments of one-fourth the circumference of the screw-thread.

If the thread of the nose-piece of the Microscope is filed down in the same way as in the adapter N, the latter may be dispensed with, and it is, as we have said, a special feature of Mr. Nelson's suggestion that the alteration to the objective thread in no way hinders its use with the ordinary nose-piece, and unaltered objectives will in the same way fit nose-pieces which have been filed down.

Gundlach's Calotte Diaphragm.—Mr. Gundlach has devised the very neat form of calotte diaphragm shown in Fig. 160, for application to his "College" Microscope (*ante*, p. 670).

Fig. 160.

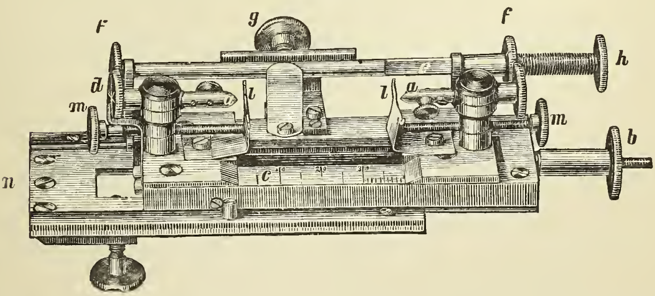


The calotte C is pierced with five apertures, varying in size from a pin-hole to $\frac{1}{6}$ inch, and is attached to a hollow metal hemisphere H, by a screw at a point 45° from the vertex, which allows it to rotate so that the apertures pass successively over an opening O at the top of the hemisphere. H itself is fixed to a spherical segment of metal, and the latter to a short piece of cylindrical tube so as to slide into the substage R; an outer shell S, of ebonite, rotates round H, and the edge of the calotte C being milled and in close contact with S, the rotation of the latter causes the calotte to revolve also. A projecting pin on the tube fits into a slot in the substage ring to prevent H from rotating.

More space for the hand between the stage and the outer edge of the ebonite shell would be obtained by adopting a conical instead of a spherical form of shell.

Bohm's Wool-measurer.* — This (Fig. 161) is intended for

Fig. 161.



examining the wool of sheep under the Microscope, but it can also be used for the anthropological comparison of human hair, as well as for

* Bericht u. d. wiss. Instrumente a. d. Berliner Gewerbeausstellung im Jahre 1879 (Loewenherz, 1880) pp. 313–4 (1 fig.).

other fibres. The hair or fibre is placed between two pincers *a* (exactly at their points). One of these is movable on the base-plate *c*, by means of the screw *b*, and the object can therefore be stretched, and the extent of the stretching read off on the scale on the plate. As, moreover, they each move on their axis, the object can be uncurled in case it is twisted, and the movement registered on a scale on the end of the screw *d*, to which an index is also attached. In order to be able to measure the various diameters of the object, it is necessary sometimes to turn it entirely round. For this purpose the bar *e* is added, whose two milled heads *f* are pressed towards the corresponding ones of the pincers *a* by means of the screw *g*, so that they act like cog-wheels. The simple turning of the bar *e* by means of the third milled-head *h* sets both the pincers in equal rotation.

This instrument also provides means for chemical treatment. For this purpose the base-plate has two spring-pieces *l* for the reception of a small slide. These supports are raised up when the pressure of the screws *m* is released, so that the object may lie on the slide. A glass cover can be placed over it, and the object treated in the usual way with alkalis, acids, &c.

By sliding the apparatus upon the plate *n* (clamped to the stage of the Microscope), the object can be passed across the field.

Gundlach's Substage Refractor.*—The formula in the description of this apparatus at p. 692 was taken verbatim from the original source, and in the bibliography at p. 699 we noted a further article by Mr. Gundlach (with a different heading) as "apparently the same as the preceding." On comparing the two articles, however, it will be seen that the earlier one was somewhat hastily prepared, and that the formula should stand as in the later one as follows:—

"For the determination of the angular aperture of objectives, if not less than 96° in crown glass, I propose to attach to the front surface of the objective, by means of a 'homogeneous' medium, in the usual way, a small piece of crown glass, which has, besides the adhering surface, two other polished plane surfaces at right angles to the former and parallel to each other, with a distance between them of at least the diameter of the front lens of the objective.

Then from two distant points, lying in the plane described by the optical axis of the objective and the perpendicular upon this axis and the parallel plane surfaces of the glass piece, let rays of light fall upon these surfaces, to pass through the glass and then through the objective.

Find, in the usual manner, by moving the lights sideways, that direction of the two light rays by which the latter will just strike the outer edge of the aperture of the objective. Then determine the angle described by the two rays before entering the glass piece, and find the true crown-glass angle of the objective by calculation after this formula:—

$$\frac{\cos i}{r} = \cos a,$$

i being half the angle of the two rays before entering the glass piece;

* Amer. Mon. Micr. Journ., iii. (1882) p. 176.

r, the refractive index of the glass piece; a, half the crown-glass angle of the objective."

Apparent Size of Magnified Objects.*—Prof. W. H. Brewer read a paper before the Section of Physics, at the Montreal Meeting of the American Association for the Advancement of Science, in which he gave the results of a long series of experiments on the apparent size of the image formed in the Microscope, as seen by different persons. About 440 different persons were questioned as to the size of the image of various objects, but finally a small insect was selected as the test object. The actual length of the image, as drawn by the camera lucida, using a $1\frac{1}{2}$-inch objective, was 4·66 inches, including the antennæ, 4·87; the diameter of the field was 5·85 inches.

The results may be briefly summed up as follows:—Of the 440 persons, about 41, or 9 per cent., judged the size quite correctly; 82 of them, or 19 per cent., made the size 4·25 to 5 inches, which was reasonably good. The greater number of persons underestimated the size; 2 estimated it at less than 1 inch, 7 made it over a foot, 45 made it 2 inches, or less; 22 made it 10 inches. The largest estimate was by a mechanic, who said it looked like a picture projected on a screen and it seemed to be 5 feet long. Experience seems to correct false estimates, as was illustrated by three estimates by a gentleman who used the Microscope in drawing; in three successive years his estimates were respectively 9, 8, and 7 inches.

Committee on Ruled Plates.—At the meeting of the Section of Histology and Microscopy of the American Association for the Advancement of Science, at Montreal, after the reading of a paper by Professor W. A. Rogers on ruled lines, a resolution was proposed that a committee be appointed to receive ruled plates from different makers that might be offered for examination in accordance with the suggestions made by Professor Rogers. After some discussion the resolution was carried, but it was afterwards decided to postpone the appointment of the committee until some future time.

Professor R. Hitchcock regards this † "as a great step toward the settlement of the question of the practical limit of resolution, independent of any theoretical considerations," and "hopes and believes that at the next meeting of the Association a committee will be appointed."

Quekett Microscopical Club.—It has been determined to give a series of demonstrations upon elementary subjects connected with Microscopy on the "Gossip" evenings of this Club. The first six will be on the following subjects:—Dec. 8, 1882, The History of a Stained Section of an Animal Structure, by Mr. J. W. Groves. Jan. 12, 1883, Photo-micrography, by Mr. T. Charters White. Feb. 9, Sea-side Collecting, by Mr. A. D. Michael. March 9, Some Methods of Preparing Parts of Insects for Microscopical Examination, by Mr. E. T. Newton. April 13, Microscopical Vision, by Mr.

* Amer. Mon. Micr. Journ., iii. (1882) p. 161.
† Ibid., pp. 197–8.

W. T. Suffolk. May 11, The Structure of Mosses, by Dr. R. Braithwaite.

We are glad to find that this experiment is at last to be tried. That it should be done has been for several years the strong wish of many of the members. As, however, it was found that the suggestion gave offence to leading officials of the Club, it was not further pressed, in the hope that at some future time the force of events would enable the question to be dealt with on its merits and apart from any personal predilections one way or the other.

Hogg on the Microscope.*—A new (10th) edition of this book (bearing the date of 1883) has just been issued. It is now so well known from the numerous editions through which it has passed, extending over a period of nearly thirty years, that it is superfluous to describe its general plan. The new edition bears the marks of extensive revision, especially in the parts relating to the Microscope proper, which have in fact been nearly rewritten.

It is almost unnecessary to say that the book contains that without which no treatise on the Microscope is now complete, viz., an explanation of the Abbe theory of microscopical vision, and of the *pons asinorum* of the old school of microscopy—the aperture of objectives. Pages 69 to 80 are devoted to the most succinct and at the same time complete statement of the latter subject that has yet been printed. A similarly succinct statement of the principles on which homogeneous-immersion is based is given in pages 82 to 86. A chapter has been added on the application of the Microscope to mineralogy and spectroscopic analysis and the examination of potable water.

By a slip the preface omits to mention that more than fifty of the new woodcuts were lent by the Council of this Society, having originally appeared in this Journal.

The author may be congratulated on the issue of the new edition and on the fact that his book has so long maintained so large an amount of popularity.

Wright's Experimental Optics.†—This is also a book on which the author may be very much congratulated, as in our view it is by far the most useful work on its subject to which the general body of microscopists can refer. It is written throughout from an experimental point of view, and the author's endeavour (to use his own words) has been "to place clearly before the mind of the reader, through something like a complete course of actual experiments, the *physical realities* which underlie the phenomena of Light and Colour. As helps, there are solely employed simple mechanical analogies, and a few diagrams, explained in language which it is hoped may be found in reality simple and clear though not intended to be childish or to debar any private student from the healthful exercise of now and then considering what the writer means." We think that the author's explanations

* Hogg, J., 'The Microscope: its History, Construction, and Application.' New (10th) ed., xx. and 764 pp., 8 pls., and 356 figs. (8vo, Routledge, 1883).

† Wright, L., 'Light: a course of Experimental Optics, chiefly with the Lantern.' xxiv. and 367 pp., 8 pls., and 190 figs. (8vo, Macmillan, 1882).

will enable those who are new to the subject to master it more readily and satisfactorily than they could do by the more usual mode of treatment adopted in the ordinary text books.

The phenomena of polarization occupy 143 out of the 358 pages of the text, and this section is illustrated by 62 figs. and 6 plates, 2 of which are beautifully coloured. There is an Appendix on 'Diffraction in the Microscope,' condensed from this Journal, I. (1881) pp. 350–5.

BRADBURY, W.—The Achromatic Object-glass. XI.
Engl. Mech., XXXVI. (1882) pp. 219–20.

Braintree Microscopical Society.
[Note on the first Annual Journal and Report.]
Sci.-Gossip, 1882, pp. 231–2.

BROWNING, J.—Letter on the Small Loss of Definition by using B, C, and D Eye-pieces. *North. Microscopist*, II. (1882) p. 282.

BULLOCH'S (W. H.) Newer "Congress" Stand.
This Journal, *ante*, pp. 666–9 (5 figs.).
Engl. Mech., XXXVI. (1882), pp. 151–2 (1 fig.)

CROUCH'S (H.) Students' Microscopes, and how to use them.
Catalogue (n.d.), pp. 25–34 (figs.).

CRUMBAUGH, J. W.—The History of the Microscope and its Accessories. III.
The Microscope, II. (1882) pp. 115–7.

D., E. T.—Drawings and Paintings from the Microscope. [*Post.*]
Sci.-Gossip, 1882, pp. 1–3.

" " Microscopical Painting. [*Post.*]
Sci.-Gossip, 1882, p. 230.

DALLINGER, W. H.—Letter on Objectives of Small and Large Aperture. [*Supra*, p. 853.] *North. Microscopist*, II. (1882) pp. 288–9.

DAVIS, G. E.—Apertures and Amplification.
[Comments on paper of J. L. W. Miles, *infra*; also remarks on Professor Duncan's Presidential Address—"it is so clearly expressed that we commend it to the notice of members of all Societies both young and old."]
North. Microscopist, II. (1882) p. 278.

" " The Elements of Microscopy. I. The Human Eye.
North. Microscopist, II. (1882) pp. 293–303 (12 figs.).

"Density"—Micro-photography.
[Inquiry whether the visual and actinic foci of an objective are the same distance apart whatever the distance of the sensitive plate from the objective.]
Engl. Mech., XXXVI. (1882) p. 282.

DIPPEL, L.—Eine neuere Verbesserung der Abbe'schen Camera lucida. (A recent improvement of the Abbe Camera lucida.) [*Post.*]
Bot. Centralbl., XII. (1882) pp. 211–2.

" " Abbe's Spectro-polarisator. (Abbe's Spectro-polarizer.) [*Post.*]
Bot. Centralbl., XII. (1882) pp. 284–6.

ENCAUSSE and CANÉSIE.—Mikrographoskop und Mikroskop zum Vergrössern und Photographiren zu gleicher Zeit. (Micrographoscope and Microscope for enlarging and photographing at the same time.)
French Patent, No. 145,999, 23rd November, 1882 (1881?).
Cf. *Zeitschr. f. Instrumentenk.*, II. (1882) wrapper.

"F.R.M.S."—Microscopy. Nelson's Adapter. [*Supra*, p. 858.]
Engl. Mech., XXXVI. (1882) p. 164.

GRAFF, T. S. UP DE.—Letter descriptive of the Elmira Meeting of the American Society of Microscopists.
The Microscope, II. (1882) pp. 123–33.
See also *infra*, Stowell, C. H. and T. B.

GUNDLACH, E.—A Simple Method of Determining the Angle of Aperture of Immersion Objectives.

[Correction of the previous description at p. 142. *Supra*, p. 860.]

Amer. Mon. Micr. Journ., III. (1882) p. 176.

HITCHCOCK, R.—The August Meetings.

[Editorial on the Montreal meeting of the Amer. Assoc. Adv. Sci. and the Elmira meeting of the Amer. Soc. Micr.]

Amer. Mon. Micr. Journ., III. (1882) pp. 176–7.

„ „ The "Jumbo" Microscope.

[Brief comment. *Supra*, p. 850.]

Amer. Mon. Micr. Journ., III. (1882) p. 178.

„ „ The Microspectroscope.

[Description of the Zeiss, Sorby-Browning and Sorby-Hilger instruments, with observations on the application of the spectroscope to the examination of solutions or fluid compounds.]

Amer. Mon. Micr. Journ., III. (1882) pp. 183–7 (3 figs.).

„ „ Committee on Ruled Plates. [*Supra*, p. 861.]

Amer. Mon. Micr. Journ., III. (1882) pp. 197–8.

HOGG, J.—The Microscope: its History, Construction, and Application; being a familiar introduction to the use of the instrument and the study of microscopical science. New ed. 8vo, London, 1883, xx. and 764 pp., 356 figs. and 8 pls. [*Supra*, p. 862.]

JENNINGS, J. H.—The Aperture Shutter.

[Letter to the Editor in commendation, both in photo-micrography and ordinary microscopic work. "Some may say, 'why not use special low-angle lenses which will give all requisite penetration?' Simply because penetration is far from being the only desirable quality in an objective. Lenses that possess great penetration usually possess little else, and the loss of light entailed by their use is far greater than that experienced when using a wide-angle lens with the aperture shutter" (!)]

North. Microscopist, II. (1882) pp. 279–80.

JONES, T. R.—Journal of the Royal Microscopical Society.

[Review of Nos. 23–9.]

Geol. Mag., IX. (1882) pp. 476–9.

KITTON, J.—The sign ×.

[Reply to T. R. J., *ante*, p. 746. "An inch is an inch, although its smaller divisions are not indicated."]

Sci.-Gossip, 1882, p. 232.

LATTEUX, P.—Manuel de Technique Microscopique, ou guide pratique pour l'étude et le maniement du Microscope. (Manual of Microscopical Technic, or practical guide for the study and management of the Microscope). 2nd ed. 8vo, Paris, 1883, xi. and 477 pp., 176 figs.

MALLEY, A. C.—Microphotography.

[Reply as to finding the actinic focus of objectives, &c.]

Engl. Mech., XXXVI. (1882) p. 257.

"Micro."—Aperture.

[Criticism of J. L. W. Miles' paper, *infra*.]

North. Microscopist, II. (1882) pp. 281–2.

Mikroskop, das, und seine Anwendung bei Untersuchung von Hopfen, Hefe &c., nebst Beschreibung und Gebrauchs-Anweisung des Hefezählers. Eine Anleitung für Brauer u. Brenner. (The Microscope and its use in the observation of hops, yeast, &c., with description of and instructions for using the yeast-counter. A guide for Brewer and Distiller.) 8vo, Berlin, 1882, 20 pp., 1 pl.

MILES, J. L. W.—The Optical Performances of Objectives—Aperture—The Aperture-shutter.

[Paper read before Manchester Microscopical Society.]

North. Microscopist, II. (1882) pp. 284–91.

„ „ Apertures and Amplification.

[Reply to J. H. Jennings *supra*, and W. Stanley *infra*.]

North. Microscopist, II. (1882) pp. 319–20.

MOORE, A. J.—Camera Lucida.

["An ingenious modification of the ordinary camera lucida, consisting of a silvered disk, somewhat smaller in diameter than the pupil, centered upon a round cover-glass, which is attached to the eye-piece in the usual manner."]

The Microscope, II. (1882) pp. 130–1.

NELSON, E. M.—Quick acting Adapter for Microscopical Objectives (Exhibition of). [*Supra*, p. 858.] *Engl. Mech.*, XXXVI. (1882) pp. 127–8.

"One who was present."—Aperture.

[Criticism of J. L. W. Miles' paper, *supra*.]

North. Microscopist, II. (1882) pp. 282–3.

PELLETAN, J.—Microscope "Continental" du Dr. J. Pelletan, construit par E. Lütz. (Dr. J. Pelletan's "Continental" Microscope, constructed by E. Lütz.)

[Detailed description.]

Journ. de Microgr., VI. (1882) pp. 458–60.

" " A propos du Microscope "Continental." (On the "Continental" Microscope.)

[Reply to C. Stodder, *infra*.]

Journ. de Microgr., VI. (1882) pp. 532–3.

"Photo."—Aperture.

[Criticism of J. L. W. Miles' paper, *supra*.]

North. Microscopist, II. (1882) pp. 280–1.

"Prismatique."—Object-glass Working. II.

Engl. Mech., XXXVI. (1882) pp. 240–1.

ROW, F.—Photo-micrography, and the Relation of Photography to Microscopy.

[Very general—26 lines.]

1*st Journ. and Rep. Braintree and Bocking Micr. and Nat. Hist. Club*, 1882, pp. 14–15 (1 photo.).

SHIPPERBOTTOM, —.—The Aperture Shutter.

[Letter to the Editor in commendation—Useful for "aiding in the production of that amount of penetration which is essential for the production of Micro-stereograms."]

North. Microscopist, II. (1882) p. 282.

STANLEY, W.—The Aperture Shutter.

[Letter to the Editor in commendation—"Polycistina placed under ½-inch objective of 80° (!) and dark-ground illumination, with the condenser. The result was a glare, no definition, no penetration, but when the aperture shutter was applied an exceedingly good dark-ground was obtained with penetration sufficient to clearly define the whole of the interior markings of some of the larger cone-like forms."]

North. Microscopist, II. (1882) pp. 278–9.

STEVENS, W. L.—The Physiology of Variable Apparent Magnification by the Microscope.

Amer. Mon. Micr. Journ., III. (1882) pp. 188–91.

STODDER, C.—A propos du Microscope "Continental." (On the "Continental" Microscope.)

[Letter to Dr. Pelletan commending the size of the new instrument as compared with the ordinary French and German models, and criticizing the length of the rackwork, the fine movement, &c.]

Journ. de Microgr., VI. (1882) pp. 531–2.

See also *supra*, Pelletan, J.

STOWELL, C. H.—Notes on the Elmira Meeting of the American Society of Microscopists and the new President. *The Microscope*, II. (1882) pp. 137, 138–9.

See also *supra*, Graff, T. S. Up de, and *infra*, Stowell, T. B.

STOWELL, T. B.—[Report of the Elmira Meeting of "the American Society of Microscopists, containing the President's Address in full." (The address is in full *abstract*.] *The Microscope*, II. (1882) pp. 97–106.

See also *supra*, Graff, T. S. Up de, and Stowell, C. H.

TAYLOR, G. C.—New Mechanical Lamp.
["A modification of the Hitchcock lamp, in which the burner is brought very low upon the table, while the intensity of the light is regulated by a movable diaphragm which increases or curtails the volume of air admitted to the fan. A practical test of the light in resolving fine lines proved its superiority over all lamps yet devised."]
The Microscope, II. (1882) p. 128.

TRUTAT, E.—Traité élémentaire du Microscope. 1e Partie. Le Microscope et son emploi. (Elementary Treatise on the Microscope. Part I. The Microscope and its employment.) xvi. and 322 pp., 171 figs., and 1 phototype. 8vo, Paris, 1883 (1882).

WARD, R. H.—Report of Committee on Eye-pieces. [*Supra*, p. 861.]
Amer. Mon. Micr. Journ., III. (1882) p. 175. Cf. also p. 171.

" " Microscopy at the American Association.
[Note on the first meeting of the new section of Histology and Microscopy and Dr. Carpenter's visit.]
Amer. Natural., XVI. (1882) p. 931.

WHEELER, E.—Lecture on Light, the Microscope, &c.
1st Journ. & Rep. Braintree & Bocking Micr. & Nat. Hist. Club, 1882, pp. 12–14.

β. Collecting, Mounting and Examining Objects, &c.

Methods of Microscopical Research in use in the Zoological Station at Naples.*—Dr. P. Mayer gives an account of the methods employed at the Naples Zoological Station for preserving, staining, and mounting objects, some of which have not previously been published. Although they are only mentioned in connection with marine forms they are in many cases applicable also to fresh-water organisms, insects, &c.

I. PRESERVATIVE FLUIDS.—*Killing*, *hardening*, and *preserving* are three kinds of work, requiring for their accomplishment sometimes only a single preservative fluid, but in most cases two, three, or even more. As the same fluid often does the work of killing and hardening, and sometimes of preserving too, it is impossible to divide them into three classes corresponding to the kinds of work, except by repeating many of them twice, and some of them three times. While it is therefore more convenient to include them all under "preservative fluids," as Dr. Mayer has done, it is none the less important to remember what

* MT. Zool. Stat. Neapel, ii. (1880) pp. 1–27. We ought long since to have printed a translation of this paper, but in consequence of a succession of accidents we have been prevented doing so, notwithstanding that we had a complete translation made of it soon after it appeared. The abstract we now give is that (with slight alterations) of C. O. Whitman in Amer. Natural., xvi. (1882) pp. 697–706, who says "I have added the methods of Dr. Giesbrecht, Dr. Andres (*infra*), and some others who have worked in the zoological station. Dr. Mayer has further placed at my disposal such improvements and alterations as he has been able to make since the publication of his paper. I am also deeply indebted to Dr. Mayer for advice and generous assistance, for which I wish here to give expression to my most sincere thanks and grateful appreciation. I am still further indebted to Dr. Eisig, Dr. Lang, Dr. Andres, Dr. Giesbrecht, Professor Weismann, and Professor Dohrn, all of whom I have had occasion to consult with reference to matter contained in this paper." Mr. G. Brook, junr., also rendered a very useful service to microscopists by publishing a summary in 'Naturalist,' vi. and vii. (1881), parts of which are embodied in the text.

kind or kinds of work each fluid is expected to accomplish. Kleinenberg's picro-sulphuric acid, for instance, now so much used in the Naples Aquarium, is not a hardening fluid. It serves for killing, and thus prepares for subsequent hardening.

1. *Kleinenberg's Picro-sulphuric acid* * :—

Picric acid (cold saturated solution in distilled water)	100 volumes
Sulphuric acid (concentrated)	2 „

Filter the mixture, and dilute it with three times its bulk of water (or for Arthropoda undiluted), finally add as much creosote (made from beech-wood tar) as will mix.†

Objects are left in the fluid three, four, or more hours; ‡ and are then, in order to harden and remove the acid, transferred to 70 per cent. alcohol, where they may remain 5 to 6 hours. They are next placed in 90 per cent. alcohol, which must be changed at intervals until the yellow tint has wholly disappeared.

The advantages of this fluid are, that it kills quickly, by taking the place of the water of the tissues; that it frees the object from sea-water and the salts contained in it, and that having done its work it may be wholly replaced by alcohol. In this latter fact lies the superiority of the fluid over osmic and chromic solutions, all of which produce inorganic precipitates and thus leave the tissues in a condition unfavourable to staining. Picro-sulphuric acid does not, like chromic solutions, harden the object, but simply kills the cells.

As this fluid penetrates thick chitine with difficulty, it is necessary, in order to obtain good preparations of larger Isopoda, insects, &c., to cut open the body with the scissors and fill the body-cavity with the liquid by means of a pipette. In larger objects care should be taken to loosen the internal organs so that the fluid may find easy access to all parts.

The fluid should be applied as soon as the body is opened, so that the blood may not have time to coagulate and thus bind the organs together. A large quantity of the fluid should be used (especially when objects with large internal cavities have to be prepared whole), and it must be changed as often as it becomes turbid. The same rule holds good in the use of all preservative fluids. It is well also, especially with larger objects, to give the fluid an occasional stirring up.

In order to avoid shrinkage in removing small and tender objects

* Quart. Journ. Micr. Sci., xix. (1879) pp. 208–9. See this Journal, ii. (1879) p. 461.

† Dr. Mayer prepares the fluid as follows:—Water (distilled), 100 vols.; sulphuric acid, 2 vols.; picric acid as much as will dissolve. Filter and dilute as above. No creosote is used.

‡ Dr. Mayer's own remarks are:—How long objects should remain in the acid depends of course upon their nature. Usually a few hours is sufficient, but for larger objects and those containing a large percentage of water a longer time is necessary. In some cases a whole day does not produce any injurious effect.

from the acid to the alcohol, it is advisable to take them up by means of a pipette or spatula, so that a few drops of the acid may be transferred along with them. The objects, sinking quickly to the bottom, remain thus for a short time in the medium with which they are saturated, and are not brought so suddenly into contact with the alcohol. In a few minutes the diffusion is finished; and they may then be placed in a fresh quantity of alcohol, which must be shaken up frequently and renewed from time to time until the acid has been entirely removed.

The sulphuric acid contained in this fluid causes connective tissue to swell, and this fact should be borne in mind in its use with vertebrates. To avoid this difficulty Kleinenberg has recommended the addition of a few drops of creosote, made from beech-wood tar, to the acid. According to Dr. Mayer's experience, however, the addition of creosote makes no perceptible difference in the action of the fluid.

Professor Emery finds the process very useful for embryos of vertebrates and for fishes, but they should not be allowed to remain in the acid more than three or four hours. Although the method is considerably the best for preserving Crustacea as a rule, it will not do for the parasitic species, in which it produces swellings, dissolution of parts of the tissues, &c.

2. *Picro-nitric or Picro-hydrochloric acid.*—Kleinenberg's fluid must not be used with objects (e.g. Echinoderms) possessing calcareous parts which it is desired to preserve, for it dissolves carbonate of lime and throws it down as crystals of gypsum in the tissues. For such objects picro-hydrochloric or picro-nitric acid may be used, prepared as follows:—

Water	100	volumes.
Nitric acid (25 per cent. N_2O_5)	5	"
[or hydrochloric acid (25 per cent. HCl)	8	"]
Picric acid as much as will dissolve.*		

Picro-nitric acid also dissolves carbonate of lime, but it holds it in solution, and thus the formation of crystals of gypsum is avoided. In the presence of much carbonate of lime, the rapid production of carbonic acid is liable to result in mechanical injury of the tissues, hence in many cases chromic acid is preferable to picro-nitric acid.

Picro-nitric acid is, in most respects, an excellent preservative medium, and as a rule will be found to be a good alternative in those cases where picro-sulphuric acid fails to give satisfactory results. Dr. Mayer commends it very strongly, and states that with eggs containing a large amount of yolk material, like those of *Palinurus*, it gives better results than nitric, picric, or picro-sulphuric acid. It is not so readily removed from objects as picro-sulphuric acid, and for this reason the latter acid would be used wherever it gives equally good preparations.

* This mixture is used undiluted.

3. *Alcohol.*—In the preparation of animals or parts of animals for museums or histological study, it is well known that the chief difficulties are met in the process of killing. Alcohol, as commonly used for this purpose by collectors, has little more than its convenience to recommend it. Dr. Mayer calls attention to the following disadvantages attending its use in the case of marine animals:—

(1) In thick-walled animals, particularly those provided with chitinous envelopes, alcohol causes a more or less strong maceration of the internal parts, which often ends in putrefaction.

(2) In the case of smaller Crustacea, e. g. Amphipods and Isopods, it gives rise to precipitates in the body-fluids, and thus solders the organs together in such a manner as often to defy separation even by experienced hands.

(3) It fixes most of the salts of the water adhering to the surface of marine animals, and thus a crust is formed which prevents the penetration of the fluid to the interior.*

(4) This crust also prevents the action of staining fluids, except aqueous solutions, by which it would be again dissolved.

Notwithstanding these drawbacks, alcohol is still regarded at the Naples Aquarium as an excellent fluid for killing many animals designed for preservation in museums or for histological work. In many cases the unsatisfactory results obtained are to be attributed not to the alcohol *per se*, but to the method of using it. Most of the foregoing objections do not, as Dr. Mayer expressly states, apply to fresh-water animals; and Dr. Eisig informs Mr. Whitman that he has no better method of killing marine annelids than with alcohol. Judging from the preparations which were shown him, and which were all beautifully stained with borax carmine, Dr. Eisig's mode of treatment must be pronounced very successful. The process is extremely simple; a few drops of alcohol are put into a vessel which contains the annelid in its native element, the sea-water; this is repeated at short intervals until death ensues. After the animal has been thus slowly killed, it may be passed through the different grades of alcohol in the ordinary way, or through other preservative fluids. Objects killed in this manner show no trace of the external crust of precipitates which arises where stronger grades of alcohol are first used. The action of the alcohol is thus moderated, and the animal, dying slowly, remains extended and in such a supple condition that it can easily be placed in any desired position. The violent shock given to animals when thrown alive into alcohol of 40 per cent. to 60 per cent., giving rise to wrinkles, folds and distortions of every kind, is thus avoided, together with its bad effects.

4. *Acid Alcohol.*—In order to avoid the bad effects of alcohol,

* Dr. Mayer first noticed this in objects stained with Kleinenberg's hæmatoxylin, and afterwards in the use of cochineal, where a grey-green precipitate is sometimes produced which renders the preparation worthless. Such results may be avoided by first soaking the objects a few hours in acid alcohol (1–10 parts hydrochloric acid to 100 parts 70 per cent. alcohol).

such as precipitates, maceration, &c., Dr. Mayer recommends acid alcohol—

97 volumes 70 per cent. or 90 per cent. alcohol,
3 „ hydrochloric acid,

for larger objects, particularly if they are designed for preservation in museums. The fluid should be frequently shaken up, and the object only allowed to remain until thoroughly saturated, then transferred to pure 70 per cent. or 90 per cent. alcohol, which should be changed a few times in order to remove all traces of the acid. For small and tender objects, acid alcohol, although preferable to pure alcohol, gives less satisfactory results than picro-sulphuric acid.

Acid alcohol as above prepared loses its original qualities after standing some time, as ether compounds are gradually formed at the expense of the acid.

5. *Boiling Alcohol.*—In some cases among the Arthropods, Dr. Mayer has found it difficult to kill immediately by any of the ordinary means, and for such cases recommends boiling absolute alcohol, which kills instantly. For Tracheata this is often the only means by which the dermal tissues can be well preserved, as cold alcohol penetrates too slowly.

6. *Osmic Acid.*—Dr. Mayer employs osmic acid as a staining medium for the hairs, bristles, &c., of the dermal skeleton of Arthropods. The lustre of *Sapphirina* is preserved by this acid,* and according to Emery, the colour of the red and the yellow fatty pigments of fishes. Van Beneden found osmic acid the best preservative fluid for the Dicyemidæ, and Mr. Whitman's experience leads to the same conclusion.†

Although Dr. Mayer seldom uses this medium where histological details are required, he observes that in those classes of animals whose bodies are easily penetrated with watery fluids, osmic acid is seldom to be dispensed with.

Bleaching.—It often happens that objects treated with osmic acid continue to blacken, after removal from the acid, until they are entirely worthless, and such results are even more annoying than the difficulties in the way of staining. It has been said that the blackening process can be arrested by certain staining media, but it is certain that picro-carmine will not always do this, as some of Mr. Whitman's preparations of Dicyemidæ show. It is therefore a very important step which Dr. Mayer has taken in finding a method of restoring such objects. The method ‡ is as follows:—The objects are placed in 70 per cent. or 90 per cent. alcohol, and crystals of potassic chlorate ($KClO_3$) shaken into the liquid until the bottom of the vessel is covered; then a few drops of concentrated hydrochloric § acid are

* See corrosive sublimate, p. 872.

† One of the best objects for testing methods is found in *Phronima sedentaria.* Here the cells and nuclei are so sharply defined that they can be seen in the living animal, and so the effect of a preservative fluid can be easily studied.

‡ A slightly modified form of the method originally given in Arch. f. Anat. u. Physiol. (Du Bois Reymond and Reichert) 1874, p. 321.

§ Nitric acid may be used instead of HCl.

added with a pipette, and as soon as chlorine (easily recognized by its greenish-yellow colour) begins to be liberated, the whole gently shaken. As soon as the bleaching is finished the objects are removed to pure alcohol. By this method Dr. Mayer has been able in half a day to restore large *Pelagia*, *Carinaria*, *Rhizostoma*, &c. Small objects generally require a shorter time and less acid. The process can be greatly accelerated by heating on a water-bath.

Using *Sapphirina* as a test-object, Dr. Mayer found that the lustre which characterizes the living animal entirely disappeared by the bleaching process. As this lustre, which has its seat in the epidermis, depends on the interference of light, it is evident that the cells had undergone some change, but a change so slight that the tissues could hardly be said to have been injured for histological purposes ; besides, the removal of the osmic acid leaves the animal in a good condition for staining.

Dr. Mayer's experience with *Sapphirina* appears to support him in the following conclusions in regard to the nature of the action of osmic acid, viz. that the hardening effect of the acid is due to the formation of inorganic precipitates within the tissues. This is made evident by the fact that the animal becomes soft and flexible as soon as these precipitates are removed by bleaching.

This method of bleaching has been used by Dr. Mayer for removing natural pigment. Alcoholic preparations of the eye of *Mysis*, for instance, can be fully bleached *in toto*, but with better success by operating with single sections. To avoid swelling, which is apt to arise by the use of aqueous fluids, staining media of an alcoholic nature should be used.

7. *Chromic Acid.*—Chromic solutions have, in common with osmic acid, the peculiarity of hardening by virtue of the chemical combinations which they form with cell-substances, and all the consequent disadvantages with respect to staining. The use of chromic acid in the Zoological Station of Naples may be said to have been largely superseded by picro-sulphuric acid, corrosive sublimate, and Merkel's fluid, for it is now seldom used except in combination with other fluids.* It is sometimes mixed with Kleinenberg's fluid, for example, when a higher degree of hardening is required than can be obtained by the use of the latter fluid alone. It is a common error to use too strong solutions of chromic acid, and to allow them to act too long. Good results are in some cases obtained when the objects are treated with a weak solution ($\frac{1}{3}$–$\frac{1}{2}$ per cent.) and removed soon after they are completely dead.

8. *Merkel's Fluid.*—

Platinum chloride dissolved in water	1:400
Chromic acid „ „	1:400

* Dr. W. Pfitzner (Morphol. Jahrb., vii. (1882) p. 731) has recently made use of chromic acid followed by (1) osmic acid, or by (2) chloride of gold, formic acid and safranin (or hæmatoxylin) for the demonstration of nerve-terminations.

Flemming believes that chromic acid is one of the most reliable fixing reagents for the karyokinetic figures, and has proved that objects hardened in this acid can be beautifully and durably stained, *ante*, p. 715.

Professor Merkel,* who employed a mixture of these two solutions in equal parts for the retina, states that he allowed from three to four days for the action of the fluid. Dr. Eisig has used this fluid with great success in preparing the delicate lateral organs of the Capitellidæ for sections, and recommends it strongly for other annelids. Dr. Eisig allows objects to remain 3–5 hours in the fluid, then transfers to 70 per cent. alcohol. With small leeches Mr. Whitman has found one hour quite sufficient, and transfer to 50 per cent. alcohol.

9. *Corrosive Sublimate.*—Prompted by a statement found in an old paper by E. Blanchard,† Dr. Lang began experimenting with corrosive sublimate as a medium for killing marine Planarians, and his marked success led him and others to employ the same with other animals. In most cases Dr. Lang now uses a saturated solution of corrosive sublimate in water. A saturated solution in picro-sulphuric acid, which in some cases gives better results if a little acetic acid (5 per cent. or less) is added, is also used.‡ Blanchard's mode of treatment was to mix a quantity of the aqueous solution with the sea-water, and thus poison the animals. Dr. Lang, on the contrary, removes the sea-water so far as possible before applying the solution. With Planarians he proceeds in the following manner:—

The animal is laid on its back and the water removed with a pipette, the solution being then poured over it, it dies quickly and remains fully extended. After half an hour it is washed by placing it in water and changing the water several times during thirty minutes. It is next passed through 50 per cent., 70 per cent., 90 per cent., and 100 per cent. alcohol. In two days it is fully hardened, and should then be stained and imbedded in paraffin as early as possible, as it is liable to become brittle if left long in alcohol. The time required by the corrosive sublimate varies with different objects, according to size and the character of the tissues. As a general rule, it may be said that objects should be removed from the fluid as soon as they have become thoroughly saturated by it. In order to kill more quickly than can sometimes be done at the ordinary temperature, the solution is heated, and in very difficult cases may be used boiling.

Corrosive sublimate has been used with success by Dr. Lang and others in the following cases:—Hydroids, Corals, Nemertines, Gephyreans, *Balanoglossus*, Echinoderms, *Sagitta*, Annelids, Rhabdocœla, Dendrocœla, Cestodes, Trematodes, embryos and adult tissues of Vertebrates and, according to Mayer and Giesbrecht, Crustacea with thin chitinous envelopes, e. g. *Sapphirina*, Copepods and larvæ of Decapods. With the Arthropoda good results have not been obtained.

* 'Ueber die Macula lutea des Menschen,' &c., Leipzig, 1870, p. 19.

† Ann. Sci. Nat. Zool., viii. (1874) p. 247.

‡ These solutions are given in Zoolog. Anzeiger, ii. (1879) p. 46. The original solution (Zoolog. Anzeiger, i. (1878) pp. 14–15, this Journal, i. (1878) p. 256) now little used, stood thus:—Distilled water, 100 parts; common salt, 6–10 parts; acetic acid, 5–8 parts; corrosive sublimate, 3–12 parts; alum (in some cases) ½ part.

The two great advantages of Dr. Lang's method are (1) that animals so treated are easily stained, and (2) they are killed so quickly that they are left, in most cases, in a fully extended condition. Hot corrosive sublimate kills leeches so instantaneously that they often remain in the attitude assumed the moment before the fluid is poured over them. The colour, however, is not so well preserved as when killed with alcohol, or even with weak chromic acid.

It should be remembered that objects lying in a solution of corrosive sublimate must not be touched with iron or steel instruments; wood, glass, or platinum may be used.

II. Staining.—It has gradually become a settled custom in the Zoological Station to mount microscopical preparations in balsam wherever this can be successfully done; and to avoid, as much as possible, the use of aqueous media, both in mounting and staining. The disadvantages often arising from the use of these media in staining alcoholic preparations include the tearing asunder of fragile tissues caused by the violent osmosis set up on transferring an object from alcohol to an aqueous solution; swelling, the effects of which cannot always be fully obliterated by again transferring to alcohol; and maceration, which is liable to result where objects are left for a considerable time in the staining liquid (as Beale's carmine). These may all be avoided by using alcoholic solutions. Objects once successfully hardened may be left in such solutions for any required time, and when sufficiently stained, be washed in alcohol of a corresponding strength, and then passed through the higher grades without being exposed to water from first to last. As a rule, alcoholic dyes work quickly, and give far more satisfactory results than can be obtained with other media. They penetrate objects more readily, and thus give a more uniform colouring where objects are immersed *in toto*. Even chitinous envelopes are seldom able to prevent the action of these fluids.

It is not, however, to be denied that non-alcoholic dyes may often do excellent work, and, in certain cases, even better than can be otherwise obtained. In the case of the Turbellaria, Dr. Lang has found picro-carmine to be one of the best staining agents, and this has been Mr. Whitman's experience with Dicyemidæ. As Dr. Mayer has remarked, the swelling caused by aqueous staining fluids is not always an evil, but precisely what is required by some objects after particular methods of treatment.

From experiments recently made, Dr. Mayer has found that dyes containing a high percentage of alcohol, stain more diffusely than those of weaker grades, from which he infers that strong alcohol robs, to a certain extent, the tissues of their selective power, and renders them more or less equally receptive of colouring matter.

1. *Kleinenberg's Hæmatoxylin.**—1. To a saturated solution of chloride of calcium † in 70 per cent. alcohol, add a little alum and filter.

* May be used after all hardening fluids.

† Chloride of calcium, according to Kleinenberg, has no other use than to strengthen the osmotic action between the hæmatoxylin solution and the alcohol contained in the tissues. As chloride of calcium and alum give a precipitate of gypsum, it would probably be better to use chloride of aluminium.

2. One volume of No. 1 mixed with 6 to 8 volumes of 70 per cent. alcohol.

3. At time of using pour into No. 2 as many drops of a concentrated solution of crystallized hæmatoxylin in absolute alcohol as suffice to give the required depth of colour. A good solution should be violet inclining a little to blue. The red tinge that arises after the fluid has stood for some time, indicates that it has become slightly acid, in which condition it is unfit for use. To restore its proper colour, it is only necessary to open a bottle of ammonia over the mouth of the bottle holding the hæmatoxylin in such a manner that a very small quantity of the gas will mix with the fluid. If too much ammonia gas be added, a precipitate is produced which spoils the fluid.

If the colour appears too strong, the fluid may be diluted with solution No. 1.

Before immersing objects in this fluid, great care should be taken to free them from the least trace of acid by frequently changing the alcohol. If this is not done thoroughly, the acid left in the preparation will sooner or later cause the colour to fade; and such results have led to the erroneous conclusion that hæmatoxylin will not give durable preparations. Dr. Mayer has found that the fading is entirely due to the presence of acid, and that with proper precautions the staining is permanent.

Small objects are best stained in a weak solution, which colours more slowly but with greater clearness than stronger solutions. After staining, Kleinenberg transfers objects to 90 per cent. alcohol. In case of over-staining, the colour may be partly removed by adding a little *oxalic acid* or *hydrochloric acid* ($\frac{1}{2}$ per cent. or less) to the alcohol containing the objects. The acidulated alcohol is allowed to work until the colour is slightly reddened. On transferring to pure alcohol the colour passes again into a permanent blue-violet.

2. *Mayer's Cochineal Tincture.*—This medium is very similar in most respects to hæmatoxylin, and is made by soaking 1 gramme powdered cochineal in 8–10 ccm. 70 per cent. alcohol for several days, and then filtering.

The clear deep red fluid thus prepared may, like hæmatoxylin, be used in all cases where it is desirable to stain with an alcoholic solution, and will be found particularly useful for objects that, by reason of the thickness of the walls or other peculiarities, are not easily penetrated by the ordinary aqueous solutions of carmine. It is particularly suited for the Arthropoda, whose chitine only allows the dye to penetrate with difficulty.

It is necessary, before immersing larger objects in this fluid, to leave them a short time in 70 per cent. alcohol, otherwise there may be a precipitate. The time required for staining will vary from a few minutes to even days, according to the nature and size of the object. For small objects, such as very thin sections, minute worms, Protozoa, the lower Arthropoda, &c., an immersion of a quarter of an hour, sometimes even less, is usually sufficient. With larger objects requiring considerable time, it is important to use a large quantity of the fluid, otherwise the amount of colouring stuff in solution might

not suffice to give the proper depth of colour. Small and delicate objects, on the other hand, may be most successfully treated with a solution which has been diluted with 70 per cent. alcohol, or one which has been weakened by previous use. It is always necessary to free the tissues, after staining, from the surplus dye; and this may be done by washing in 70 per cent. alcohol, which must be changed until it shows no colour. This process requires, for larger objects, considerable time and alcohol, but may be hastened by using the alcohol slightly warm.

The colour ultimately assumed by objects treated with cochineal tincture varies much, and depends partly on the reaction of the tissues themselves, partly on the presence or absence of certain salts. It is certainly one of the best recommendations of this staining agent that varying with the nature of the object and its mode of treatment both before and after staining, it gives such an extraordinary diversity of results. On account of the great variety of substances contained in the dried dye-stuff, it is evident that the composition of the tincture must vary according to the strength of the alcohol employed as a solvent. Solutions in 90 per cent. or 100 per cent. alcohol have a light red colour, and stain too diffusely to have any practical value. The weaker the alcohol the stronger the tincture, and the stronger the alcohol the more easily it penetrates objects; the grade of alcohol may therefore be selected with reference to two points, depth of colour and readiness of penetration; 70 per cent. or 60 per cent. is recommended by Dr. Mayer as combining both these qualities in a very favourable degree. It is important to remember that whatever be the strength of the solution, a precipitate will always be produced if an alcohol of a different grade, whether higher or lower, be mixed with it. It is evident, then, that a tincture of any given strength contains substances that are insoluble in any other grade of alcohol, and this explains why superfluous colouring matter can only be removed from objects by the aid of alcohol of precisely the same degree as that of the tincture.

Over-staining, which seldom occurs, may be easily corrected by the aid of acid alcohol ($\frac{1}{10}$ per cent. hydrochloric acid, or 1 per cent. acetic acid). Acid makes the tincture lighter, more yellowish-red, while the addition of ammonia and other caustic alkalies changes it to deep purple. Still more important is the fact that salts soluble in alcohol give a blue-grey, green-grey, or blue-black precipitate. For example, if a piece of cloth that has been dyed in cochineal and washed be treated with an alcoholic solution of a ferric or a calcic salt, it will assume a more or less deep blue colour.

As the salts present in the living organism are seldom, if ever, fully removed by preservative fluids, but in some cases even increased, it will often happen that an object, though put in the red fluid, comes out blue, precisely as when stained with hæmatoxylin. Such a result cannot, however, be obtained where the tissue is in the presence of acids, or free from inorganic salts; under these conditions the colour is always red. It is not possible, therefore, to know what colour an object will ultimately present.

Usually, all Crustacea with thick chitinous parts are stained red, and most other animals blue; so that, for instance, the Vorticellidæ, which are parasitic on the Amphipoda, can be at once recognized as foreign bodies. Very often the different tissues of one and the same object present unlike colours. In the embryos of *Lumbricus*, Kleinenberg found the walls of the blood-vessels red, their contents dark-blue. Glandular tissues, or their contents, are frequently stained grey-green, and on this account are easily recognizable.

Objects when previously treated with chromic or picric solutions, or with alcohol, usually stain without difficulty; but osmic acid preparations should be bleached before staining. Cochineal does not colour so intensely as hæmatoxylin, and hence the latter often gives more satisfactory results in the case of large objects stained *in toto*.

As before pointed out, alcohol causes the salts contained in sea-water to be precipitated, thus forming a crust on the exterior of the animal, which interferes with the staining process. It is therefore necessary to treat marine animals that have been preserved in strong alcohol, with acid alcohol (1–10 parts hydrochloric acid to 1000 parts 70 per cent. alcohol), and then carefully wash in pure 70 per cent. alcohol before staining with cochineal.

3. *Carmine and Picrocarmine.*—Aqueous solutions of staining media are generally only used when alcoholic cannot be employed. The interpretation of the results obtained by carmine staining is not always satisfactory. For instance, in his work on the nervous system of *Aquilla*, Bellona describes the peculiar crescent-like structures in the ganglion cells. Dr. Mayer is of opinion that these are entirely artificial productions, and owe their origin to the carmine (Beale's) solution in which they were stained, for with careful preparation they do not appear. Picrocarmine is more certain in its results, and in some cases will give better specimens than can be obtained by any other medium. In commerce it often contains too much picric acid, and it is better to prepare it oneself in the following manner:—

To a mixture of powdered carmine (2 g.) with water (25 ccm.), while heating over a water-bath, add sufficient ammonia to dissolve the carmine. The solution may then be left open for a few weeks (Mayer) in order that the ammonia may evaporate; or the evaporation may be accelerated by heating (Hoyer). So long as any ammonia remains, large bubbles will form while boiling, but as soon as the free ammonia has been expelled, the bubbles will be small and the colour of the fluid begin to be a little lighter. It is then allowed to cool, and filtered. To the filtered solution is added a concentrated aqueous solution of picric acid (about four volumes of the acid to one of the carmine solution). The addition of the acid should cease before a precipitate begins to form.

In order to protect this fluid against changes attributed to bacteria by Hoyer,* Dr. Mayer places a small crystal of thymol in the con-

* Hoyer, "Beitr. z. histolog. Technik.," Biol. Centralbl., ii. (1882) pp. 17–19.

taining bottle; Hoyer uses choral-hydrate (1 per cent. or more) for the same purpose.*

4. *Acetic Acid Carmine.*†—Pulverized carmine added to a small quantity of boiling acetic acid (45 per cent.) until no more will dissolve; filtered and diluted to about 1 per cent. for use.

Flemming used the concentrated solution.

5. *Grenacher's Carmine Solutions.*‡ — (i.) *Alum Carmine.* — An aqueous solution of alum (1–5 per cent., or any degree of concentration) boiled with $\frac{1}{2}$–1 per cent. powdered carmine for 10-20 minutes; allowed to cool, then filtered.

With the addition of a little carbolic acid the fluid will keep for years. It colours quickly, and nuclei more strongly than other parts. Objects washed in water after staining.

(ii.) *Acid Borax Carmine.*—*a.* An aqueous solution of borax (1–2 per cent.) and carmine ($\frac{1}{2}$–$\frac{3}{4}$ per cent.) heated till the carmine is dissolved.

b. Acetic acid added by drops to solution *a*, while shaking, until the colour is about the same as that of Beale's carmine.

c. Solution *b* left standing twenty-four hours, then turned off and filtered.

This solution, which is a modification of Schweigger-Seidel's acid carmine, is not recommended for colouring *in toto.* It colours sections in $\frac{1}{2}$–3 minutes diffusely, and hence, after washing in water, they are placed for a few minutes in alcohol (50 or 70 per cent.) to which a drop of hydrochloric acid has been added; then transferred to pure alcohol.

(iii.) *Borax Carmine.*§—*a.* An aqueous solution of borax (4 per cent.) and carmine, heated till the carmine is dissolved.

b. Solution *a* mixed with 70 per cent. alcohol in equal parts, left standing twenty-four hours and filtered.

This fluid may be used for colouring objects *in toto.* After staining, the objects are to be washed in 35 per cent. alcohol, to which a little hydrochloric acid has been added (4–6 drops to 100 ccm.), and allowed to remain here until the colour has been sufficiently removed. They are next passed through successively higher grades of alcohol for hardening.

(iv.) *Alcohol Carmine.*—A teaspoonful of carmine dissolved, by heating about ten minutes, in 50 ccm. of 60–80 per cent. alcohol, to which 3–4 drops of hydrochloric acid have been added, then filtered.

* Dr. Lang's picro-carmine and eosin method for Planarians, see this Journal, ii. (1879) p. 163, is also referred to. Dr. Mayer does not expect any particular advantage from its application to Arthropods.

† Schneider, Zool. Anzeig., 1880, p. 254.

‡ Grenacher, "Einige Notizen z. Tinctionstechnik," Arch. f. Mikr. Anat., xvi. (1879) p. 463. None of these solutions should be used where calcareous parts are to be preserved.

§ Dr. Mayer prepares, for some purposes, borax carmine of 50, 60, or 70 per cent. That of 70 per cent. contains little carmine, but is well adapted to staining delicate objects that would suffer if exposed to weaker solutions. Boiling alcohol (50 per cent. or 60 per cent.) dissolves about 1 per cent carmine and 1 per cent. borax.

Objects coloured in this fluid should not be washed in water, but in alcohol of a grade corresponding to that of the solution.

For diluting alcoholic solutions of carmine, alcohol of the same strength must always be used.

6. *Aniline Dyes.*—As a rule, aniline colours and the many others obtained recently from tar by chemical processes, cannot be used for staining objects *in toto*, and are therefore not much employed in the Zoological Station. In very small objects and sections already cut, very excellent results can be obtained by the methods developed by Böttcher,* Hermann,† Flemming ‡ and others; for here diffuse staining may generally be avoided by first over-staining and then withdrawing the colour to any desired extent by means of alcohol. But to obtain satisfactory results, the sections must be thin enough to allow uniformity of action both to the colouring and the decolouring agent. It is evident that the process cannot be similarly controlled in larger objects, particularly where a dye is used, which, like most of those under consideration, is quickly extracted by alcohol, for in this case the colour would be removed from the superficial layers more rapidly than from the deeper ones, so that a uniform precision of colour would be impossible. In this respect,

a. Bismarck-brown forms an exception. The preparation of this dye, introduced by Weigert,§ is extremely simple:—

A saturated solution is made by dissolving the powder in boiling water or weak alcohol, or, according to Mayer, in 70 per cent. alcohol.‖ The solution should be used undiluted, and requires to be filtered from time to time. It colours very quickly objects hardened in alcohol or chromic acid.

b. Safranin.—1 part safranin dissolved in 100 parts of absolute alcohol; after a few days 200 parts of distilled water is added.

Dr. Pfitzner,¶ from whom the above formula is taken, recommends this solution as one of the best for staining nuclei. It is cheap, easily prepared, acts quickly, and stains only the nuclei. It works best with chromic acid preparations, from which the acid has been removed as much as possible.

Unless therefore it is desired to differentiate membranes or display the various stages of ossification this group may be dispensed with.

III. Injecting.—Professor Emery, who has lately studied the methods of injection, recommends the following:—

a. For injection of *thick carmine* he follows the prescription of Ranvier, in his 'Traité d'histologie technique,' but neutralizes the mass in a more simple way. Acetic acid is added by drops until the

* Böttcher, Mull. Archiv, 1869, p. 373. Virchow's Archiv, xl. p. 302.

† Hermann. Communicated to the Naturforscherversammlung in Graz, 1875. Tagblatt, p. 105.

‡ Flemming, Arch. f. Mikr. Anat., xiii. p. 702; xvi. p. 302; xviii. p. 151; xix. pp. 317, 742; xx. p. 1.

§ Arch. f. Mikr. Anat., xv. (1878) p. 258.

‖ According to Flemming, it may also be dissolved in dilute acetic acid.

¶ Morph. Jahrb., vi. pp. 478–80, and vii. p. 291.

smell of the ammonia becomes very faint. The reaction of the vapour is then tried with litmus paper. Sufficient acid has been added when the litmus paper begins to get red. Often, on stirring, the alkaline reaction will return, but this must be removed with another drop of acetic acid. In use it will be found that with a neutral or slightly acid mass, a diffusion of the medium through the cell-walls is scarcely likely to occur.

b. As a cold fluid mass, Emery recommends a 10 per cent. carmine solution prepared with ammonia, to which, while continually stirring, acetic acid is added until the carmine begins to be precipitated, and the liquid has a blood-red colour. The clear liquid only must be used, and after injection, the objects must be at once placed in strong alcohol, to fix the carmine.

c. For injecting the capillaries, good results are often obtained by gradually mixing 10 per cent. carmine solution with acetic acid, until part of the carmine is precipitated. The solution must be shaken shortly before use, only allowing it to settle for a few minutes, so that the coarser grains do not get into the syringe. In injections from the arteries a considerable quantity of fine sediment remains in the capillaries, while only a light fluid enters the veins. Thus the veins can easily be distinguished from the arteries, which are dyed dark red.

IV. Mounting.—The great object aimed at, in preparing permanent preparations for the Microscope, is to entirely get rid of the water in the tissues of the object, and supplant it by a preservative medium. Hence, at Naples the aqueous mounting media such as glycerine, glycerine jelly, acetate of potash, &c., are in little favour. After the water has been forced from the object and supplanted by alcohol, the process is usually completed by passing through oil of cloves, and mounting in balsam. Usually there is little trouble with this method. The oil of cloves, or other similar oil, is slightly heated, and as a rule it will penetrate the tissues without trouble. With larger objects, however, and particularly those with thin but not easily permeable walls, the alcohol will often leave before the oil can enter, and there will be a collapse of the walls. *Creosote* has been used to prevent this shrinking, but it appears to render no permanent good. Dr. Mayer meets the difficulty in the larger objects by making an insertion with a fine pair of scissors in an unimportant part of the body-cavity, so as to allow the oil to enter at once. This answers very well, and can be used with very small objects, such as *Auricularia* and other larvæ, if a fine flattened needle be used. If this should fail, and especially when the number of objects to be transferred to balsam is large, the alcohol may be supplanted gradually. Dr. Mayer has thus prepared very young larvæ of Echinoderms. The specimens were taken up in a capillary tube, with the surrounding alcohol, and then placed in a tube, with a drop of oil of cloves at the bottom. After the lapse of half-a-day the larvæ, which at first swam on the top of the oil, had gone to the bottom of it, and could be easily removed again by the same tube. Objects may be left in oil of cloves for months without any apparent detriment.

Recently Kleinenberg has recommended the use of *colophonium* instead of Canada balsam. The solution in absolute alcohol is not suitable, as under certain circumstances the finished preparations will show large bundles of crystals. Turpentine should be used as a solvent; this, however, has the disadvantage that the preparations dry very slowly. The solution in chloroform seems to answer well, but must be filtered before use. Further experience is required with this medium before its use can be strongly recommended.

A solution of *sandarac* in absolute alcohol, which at first appeared to answer well, has not, on further trial, proved satisfactory.

V. Dissecting.—For the dissection of single organs, fresh animals are generally placed in dilute alcohol, or a weak chromic solution. But the tissues are liable to suffer from maceration in these fluids, and hence, where it is important that the tissues should be well preserved, it is advisable to use picro-sulphuric acid, regardless of the injurious effects of the same on the dissecting instruments. The fluid should be changed as soon as it gets thick and the preparation well washed in alcohol afterwards. The hardening capacity of the picro-sulphuric acid is extremely slight, but may be strengthened by the addition of chromic acid. Preparations thus obtained, and subsequently treated with alcohol, staining fluids, &c., should be transferred to creosote for further dissection, as the transparency induced by this medium will greatly facilitate the work.*

VI. Imbedding.—For section-cutting, objects are usually imbedded in paraffin. By low temperature, as in winter, it is necessary to work with a softer paraffin than is required for summer. Instead of softening by an admixture of lard, as generally done, it is better to use a paraffin which becomes soft in summer, on account of its containing liquid hydrocarbons, and is preferable to lard as it is not liable to become rancid.

Preparatory to imbedding, the objects are removed from absolute alcohol † to creosote, clove oil, or chloroform, and left until they become thoroughly saturated. The penetration of the clarifying fluid may, in some cases, be advantageously hastened by warming a little. They are next placed in soft paraffin, heated to about 50° C. over a water bath, and allowed to remain for an hour or so. The soft paraffin is then turned off and replaced by a mixture of hard and soft paraffin,‡ heated to about 50° C. After remaining for half-an-hour or less in the harder paraffin, kept at a steady temperature, they are ready for imbedding. For this purpose a small paper box may be used; or, much better, a box made of two pieces of type-metal, as used in Professor Leuckart's laboratory. As will be seen from Fig. 162, each

* In the original paper Dr. Mayer speaks not of creosote, but of oil of cloves. The brittleness which is caused by it is in most cases advantageous, but can easily be reduced by the addition of creosote. The tendency to collect in small drops which is peculiar to oil of cloves may be counteracted by the addition of oil of bergamot.

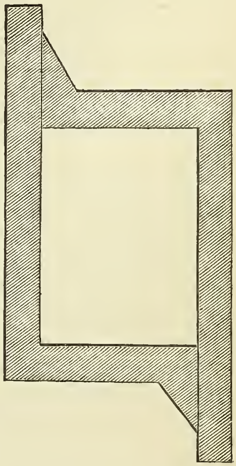
† In many cases a lower grade of alcohol will suffice.

‡ The ratio of combination must be determined by experiment, since it will depend on the quality of the paraffin and the temperature; two parts of hard to one of soft work very well for the winter temperature of Naples.

piece of metal has the form of a carpenter's square, with the end of the shorter arm triangularly enlarged outward. A convenient size will be found in pieces measuring 7 cm. (long arm) by 3 cm. (short arm), and 7 mm. high. With such pieces a box may be constructed at any moment by simply placing them together on a round plate of glass, which has previously been wet with glycerine and gently warmed. The area of the box will evidently vary according to the position given to the pieces, but the height can be varied only by using different sets of pieces. In such a box the paraffin may be kept in a liquid state by warming now and then over a spirit-lamp, and small objects be placed in any desired position under the Microscope.

It is well to imbed in a thin layer of paraffin, so that the object, after cooling, may be cut out in small cubical blocks, which may be easily fixed, for cutting, to a larger block of hard paraffin.

Fig. 162.



Only in the case of very delicate objects is imbedding in wax and oil after Brücke's plan to be preferred. White of egg has not proved as permanent as might be desired. Gelatine is a convenient imbedding medium, and Dr. Mayer has devised a process by which it is deprived of its elasticity. It is allowed to soak as usual in water, then heated and $\frac{1}{4}$ to $\frac{1}{2}$ a volume of castor oil added, shaken well, and shortly before getting cold pour the mixture into a bowl. When afterwards all the castor oil has been extracted by 90 per cent. alcohol the gelatine remains as a fine porous matter, a sort of artificial pith, and is at once ready for use. It must not of course be exposed too long to the air as this would soften it. Under the Microscope this form of gelatine is less troublesome than lilac pith and has the advantage that it can be produced in any size and always even.

VII. Cutting.—Objects are cut dry with a microtome, and the rolling of the sections may be prevented by holding a thin narrow spatula over the edge of the knife while cutting. The spatula may be made of brass, or of paper fastened to a flattened needle. The spatula should be bent slightly, and the convex face held over the paraffin without pressure. A small brush, slightly flattened, is used for the same purpose in Leipzig.

Andres' Methods of treating Actiniæ.* — Among the various methods employed by Dr. Andres in killing the Actiniæ, the three following, given in the order of their excellence, are said to have worked most satisfactorily:—

A. *Corrosive sublimate.*—With small animals a hot solution, used in the manner recommended by Dr. Lang, gives good results; with

* Atti R. Accad. Lincei, v. (1880) p. 9.

larger animals, where this mode of treatment fails, the fluid must be injected. The cannula of a glass syringe, filled with the hot fluid, is inserted into the mouth at the moment it opens, which act habitually follows on gently touching the lip. After injecting, the hot solution is poured into the glass containing the animal and a small quantity of sea water.

If the operation is cleverly performed, the animal remains fully expanded, as the mechanical pressure of the injected fluid prevents contraction.

After from five to fifteen minutes the animal is washed in distilled water, and allowed to remain twelve hours in 50 per cent. alcohol,* then passed through the higher grades of alcohol. Borax-carmine and hæmatoxylin used for staining.

B. *Glycerine and Alcohol.*†—

Glycerine	20 parts.
Alcohol (70 per cent.)	40 „
Sea water	40 „

This mixture, poured very slowly into the containing glass, often gives very good results, both for anatomical and histological purposes.

C. *Nicotine and Tobacco Smoke.*—*a.* A solution of nicotine (1 g.) in sea water (1 l.), conducted into the vessel containing the animal fully expanded in a half litre of sea water, by means of a thread sufficiently large to empty the flask holding the nicotine solution in the course of twelve hours.

b. The vessel containing the animal in an extended condition, covered by a bell-jar in which tobacco smoke is confined, until the animal becomes completely benumbed.

After being deprived of sensibility by either of these methods, the creature may be killed in corrosive sublimate, or in picro-sulphuric acid.

D. Dr. Andres finds that in the use of chloroform, dropped slowly into the water, or administered in form of vapour, maceration usually sets in before the power of contracting is lost. Good preparations of the internal parts may be obtained by injecting a weak solution of osmic acid. The method of freezing has also been employed with some success. For this purpose three vessels are placed one within the other, the central one containing the *Actinia*, the middle one ice and salt, and the outer one cotton.

The ice containing the congealed animal is dissolved in alcohol or an acid.

E. *Maceration.*—It is often important to see the cells of a tissue *in situ* before freeing them with needles. In such cases Dr. Andres proceeds as follows:—

1. Killed with corrosive sublimate.
2. Left in 25 per cent. alcohol twenty-four hours.

* A little camphor (1–100 ccm.) added to the alcohol will facilitate the removal of the sublimate.

† This method originated with S. Lobianco.

3. Soaked for a short time in a very thin solution of gum arabic then in a somewhat thicker solution, and finally imbedded in a very thick solution.
4. Hardened in 90 per cent. alcohol.
5. Thick sections prepared for dissection with needles. The sections are placed on a slide in water, which dissolves the gum.

Flemming's further Method for Staining Nuclei.* — In his recent researches on karyokinesis, W. Flemming states that he obtained serviceable staining of nuclei in the following ways:—

1. Living eggs of Echinoderms coloured on the slide, either with safranin or aniline dyes, followed by acetic acid (1 per cent.) which is allowed to flow under the cover and thus replace the staining medium, or with acetic acid carmine (after Schneider), used undiluted. The last mentioned staining agent causes swelling, but still gives the typical features of the karyokinetic figures.

2. Eggs first hardened in strong nitric acid (40–50 to aq. dest. 60–50), then washed in distilled water until the yellowish colour, due to the presence of the acid, disappears. Coloured with acetic acid carmine.

Iodine-green and Methyl-green.†—Dr. M. Flesch calls further attention to the suitability of the combination of the green with red staining matters. He has excellent preparations of cartilage, skin, and glands hardened in Müller's fluid and alcohol, and stained with methyl-green, and afterwards with picrocarmine. If the colour is not so beautiful as in the case of objects stained with carmine and hæmatoxylin, it is nevertheless very useful, as it is, he believes, easy to preserve, and moreover it gives very sharp differentiations.

Dr. Flesch uses an aqueous solution of commercial methyl-green diluted until the section in a watch-glass is still recognizable on a bright ground.

Preparation of Epidermis.‡—W. Pfitzner prepares the epidermis of tadpoles by first hardening in chromic acid, and making fine sections with the Thoma microtome of a piece as free as possible from pigment, imbedded in elder pith; the best thickness for the sections is ·01 to ·015 mm. The sections are washed for at least thirty minutes in distilled water to remove the chromic acid.

Pfitzner has three methods of mounting, either of which may be employed, with various modifications:—

1. Staining. *a.* With saffranin, mount in dammar. *b.* With hæmatoxylin, mount in dammar; or, *c.* As *b*, but mount in glycerine.

2. Gold treatment:—Treatment with 1 per cent. solution of gold chloride, with a trace of hydrochloric acid, for 15 to 30 minutes, in the dark; the sections are then carefully washed and exposed to daylight for 12 to 24 hours in a 5 per cent. solution of formic acid,

* Arch. f. Mikr. Anat., xx. (1881) p. 1. Cf. Amer. Natural., xvi. (1882) p. 780. See also Flemming's earlier method, *ante*, p. 715.
† Zool. Anzeig., v. (1882) pp. 554–5.
‡ Morpholog. Jahrb., vii. (1882) pp. 731–2. See also *ante*, p. 871.

and then carefully washed again and mounted (*a*) simply in glycerine, or (*b*) in dammar, after staining with saffranin.

The delicacy of the sections necessitates the employment of good daylight, and illumination from below in their manipulation; the latter end may be attained by employing as working stage a cigar box, from which the front side has been removed, putting a piece of glass on the top, and an oblique mirror inside. Great care must be taken not to allow contact between the sections when made, as they would then probably become entangled.

Unpressed Mounting.*—Under this heading Mr. A. W. Stokes describes the mounting of the tongue of a blow-fly "without pressure," so that its true shape is preserved, a halfpenny test-tube being all the preparing apparatus required.

Into this test-tube place the fly's head, and fill the tube half-full with a solution of soda and potash. Stand the tube in boiling water, and leave it on the hob of a fire to keep hot till morning. Then examine the head and see if it looks almost transparent; if not, pour off the soda solution and add a fresh supply, and again keep the tube hot till the object becomes semi-transparent. Now pour off the solution and add hot water, in a few minutes emptying it out and adding some more:—Repeat this at least three times, and finally leave the last quantity of water on the object for an hour to cool. Next pour off all the water and replace it with spirit of wine; methylated spirit, if strong, will do sufficiently well. Heat this by immersing the tube in a vessel of hot water for one minute; then take it out, cork it up, and leave it for one hour.

So far we have, by means of the soda-solution, destroyed all the flesh and fat tissues, leaving only the cuticle and internal organs, such as the tracheæ, &c. In doing this, we have filled up most of the few natural air-spaces with soda-solution, which, however, being a somewhat dense fluid, would not enter many of the narrow tracheal tubes. Then with water we replaced the soda-solution, and washed away the parts destroyed thereby. On replacing the water by alcohol, a still less dense fluid, more of the finer air-spaces are penetrated and the air driven out; there are still, however, some tubes too minute even for alcohol rapidly to enter. So now we pour off the spirit, and add ether instead, which answers a double purpose; it enters the very minutest passages, displacing the contained air, and it also dissolves the globules of fat left unsaponified by the soda-solution. After leaving the ether for fifteen minutes in the corked tube, and shaking it once or twice, we pour it off and add turpentine; and then in ten minutes time the head is ready for mounting in Canada balsam or dammar.

If so mounted, however, it will be very difficult to see much of the finer internal structure, since these media render some parts far too transparent; and hence some of the glycerine media are preferable. In such cases, after pouring off the ether, add alcohol, and at the end of fifteen minutes replace the alcohol with cold water, and

* Journ. Post. Micr. Soc., i. (1882) pp. 129–35.

leave for fifteen minutes more. Then the water may be poured off, and the mounting-fluid, whether glycerine, carbolic-acid, gelatine, Goadby's or Thwaites' fluid, may be added. The object, if mounted in any of these, will have a far more natural appearance, and show more plainly the finer structures, than if mounted in Canada balsam. The times mentioned above are those it is *necessary* in most cases to wait, but longer intervals would often be preferable. If we are busy the tube and its contents may be left at any stage of the proceedings for days, with a certainty that the object will only benefit by the delay, *except* in the case of the soda-solution. It is not necessary to use distilled water, though it is better to do so; but whatever water is used, it should be just freshly boiled and be used hot. Cold unboiled water contains a large quantity of air, and if used in that state will certainly impart air to the object instead of helping to extract it.

The soda or potash solution is made by adding solid potash or soda to eight times its weight of boiling water, and the only expense of the process is for the tube, soda, alcohol, and ether—a pint of each of the latter will prepare some thousands of specimens.

The same system will answer for sections of wood, small seed-vessels, leaves, &c., only they must first be decoloured by pouring sodic hypochlorite into the tube, then, after well washing with water, the rest of the process may be followed as before, leaving out entirely the use of the soda-solution. The great difference is in the matter of speed, vegetable preparations being made far more rapidly. It is possible to cut a dozen sections from a living branch, bleach, stain, and mount them in Canada balsam or glycerine-solution, and finally, ring and label them, all within the hour.

Should any of the preparations—the blow-fly's head, for instance —become too colourless and transparent, all we have to do is to stain them by the addition of a few drops of an alcoholic solution of some colouring matter (logwood answers well) to the alcohol in the tube. The subsequent use of ether will fix the colour.

Usually, after this treatment, the object will be found to be quite clean; but if not, it should be gently brushed with a camel-hair pencil while in the turpentine or glycerine fluid. The wings of many insects are partially destroyed during the process, but since these can, if desired, be easily mounted separately, this is not of very great importance.

Directions are also given for mounting the object as above prepared in cells, the use of vulcanite rings being recommended.

Staining with Magdala-red.*—Dr. C. Nörner refers to the fact that picrocarmine (Ranvier's) affects different classes of animals very differently. Tape-worms, for example, redden very quickly, while other worms, like the Nematodes, take very gradually a yellowish tinge, because in their case the picric acid takes effect first and the carmine only after a longer time. Mites are also affected variously—some become yellow, others red, and others perhaps remain colourless. Magdala-red is not open to these objections, and

* Arch. f. Mikr. Anat., xxi. (1882) pp. 354–5.

is an exceedingly useful staining medium, because it answers all requirements in an equally favourable way. It possesses a marked differentiating power, and even surpasses picrocarmine in this excellent quality. It colours all tissues uniformly, whether they are fresh or are taken out of alcohol or chromate of potash. What is most important is that the differentiating power is well manifested in botanical preparations, in which each tissue takes a special tint. Care however must be taken that the sections remain only a few minutes in the solution, because it stains with remarkable intensity. For the examination of sieve-tubes (preserved with so much difficulty) Magdala-red will doubtless be very suitable. The vessels of the plerom are very clearly distinguished from the periblem, &c. The lower fungi also, such as *Mucor*, *Penicillium*, *Aspergillus*, &c., also take a beautiful colour, like histological sections. An exceedingly satisfactory result is likewise obtained with parasites (mites, worms, &c.). A further advantage is that this dye has a great capacity of resistance to potash, and thus, if required, specimens can be first stained and then treated with potash. For double staining it does not seem to be suitable, as it destroys the other colour.

The author adds, "whether it does not possess the same disadvantage as hæmatoxylin and other aniline colours, and disappears from the preparation after a time, and is therefore unstable, I am not yet able to determine."

Preparing Fossil Foraminifera, Spicules, &c.*—In a second paper † Mr. C. Elcock gives directions for preparing fossil Foraminifera. The material from which they may be most easily prepared is chalk powder, many ways of doing which are recommended by text-books, but all unsatisfactory in practice.

The only material worth handling from which to obtain the Foraminifera found in the chalk in a condition almost, if not quite, uninjured, is the powdery matter found in the cavities of the flints which abound in the chalk, but especially in cavities in the large nodules known as "Paramondras"—masses of flint of very irregular ovoid form in which are cavities of various sizes filled with chalk containing Foraminifera, which as a rule are in fine preservation.

On no account should the plan be adopted of shaking up the powder with water in a bottle, which is worse than useless; but if it is dry, the first thing is to sift it through a rather coarse sieve—zinc perforated with holes $\frac{1}{16}$ inch in diameter will do—so as to remove all the fine flakes of flint, which would cut gauze like lancets. If damp or wet, the powder may be *washed through* this zinc sieve under the tap into a sieve (9 inches in diameter and 4 inches deep), with Miller's silk-gauze 180 threads to the inch. Either way will answer well, but after much experimenting Mr. Elcock prefers first to dry perfectly and sift dry. What will not pass through this zinc sieve must be well and carefully washed, and looked over when dry, as it will contain

* Journ. Post. Micr. Soc., i. (1882) pp. 139–45.

† First paper (on recent Foraminifera) loc. cit., pp. 25-9. Cf. this Journal, *ante*, p. 436.

the largest forms, some of which, as *Nodosaria*, *Dentalina*, &c., may be nearly half-an-inch long.

A large cup-full of the fine sifted powder must now be put into the silk-gauze sieve, and a good stream of clear fresh water be allowed to wash it until all signs of milkiness have disappeared, and the water runs away quite clear, neither fingers nor spoon being used to stir up the material, but letting the stream of water from an indiarubber tube fixed to the water supply do all the work, directing it so as to move the powder well about. When the water runs away clear, wash all into a corner of the sieve, drain, and tip out the chalk powder on to a plate to dry *thoroughly* in the oven. Repeat this process until all is washed; and when dry and cold sift into sizes for examination. The finest siftings will probably be the richest in species. If the chalk-powder is good and the washing properly done, a considerable portion will be found to consist of Foraminifera, Ostracoda, sponge, and other spicules, the remainder being sand, &c.

If sponge spicules or other siliceous organisms only are being sought for, pour dilute hydrochloric acid over the chalk-powder, and let it remain for a day or two to remove all the lime; after which pour off the acid, and wash well with clean water until every trace of the acid is removed; then dry, sift, and examine.

As these Foraminifera are fossil and mostly siliceous they will not "float," but the washed material must after drying be examined under the Microscope and the individual shells picked out with a fine miniature red sable pencil, and for doing which there is no royal road. The best tray for the purpose is one made of black ferrotype plate 4 inches $\times$ $1\frac{1}{2}$ inch with the edges on each side and one of the ends neatly turned up about $\frac{1}{16}$ inch, on which a layer of the washed material is spread as thinly as possible, and the tray passed regularly from right to left across the field.

Directions are also given for dealing with fresh dredgings of sea-mud, shore-mud ,&c., and with ship's soundings, where the Foraminifera are mixed with tallow, lard, &c.

Of all ways of mounting Foraminifera none is to be compared with mounting them as opaque; they look best without a cover-glass. Ebonite rings should be selected of such sizes that one will just fit inside the other, the smaller being cemented to the slide and the larger to the cover-glass.

Preparation of Diatoms.*—Prof. J. Brun describes the following process which he employs for destroying the endochrome of diatoms.

If the diatoms are fresh and wet, crystals of permanganate of potash should be added, and 10 parts water for each 1 part of the salt. If the diatoms are dry (pure or mixed) they should be wetted with a little of the concentrated solution of the salt, having even crystals in excess. The reaction of the permanganate should last about 12 hours.

The mixture (placed in a 100 gr. phial) should be stirred occasionally and put in the sun or on a warm stove. The phial should

* Journ. de Microgr., vi. (1882) pp. 457–8.

then be half filled with water and 0·50 cgr. of calcined magnesia added and left to act for 2 or 3 hours, shaking it now and then. Pure hydrochloric acid is then added in 1 gramme doses every 10 minutes, and when the contents of the phial are colourless the operation is completed. To facilitate the reaction the phial may be plunged in warm or boiling water. The absolute purity of the distilled water to be used for the subsequent washings is an essential condition of success.

In this process we have first the energetic oxidization of the endochrome by the permanganate, then, by means of the acid, there is a disengagement of oxygen (or combustion), and finally the disengagement of chlorine which bleaches. It is to these successive reactions inside and outside the valves, to which must be attributed the perfect cleansing of their silex. By this treatment the delicate species are not corroded, particularly if, before the action of the acid, enough water is added.

The surfaces of the valves will be found to have lost all their coleacterine, and the minuter details, striæ or dots, clearly shown. The author has tried all the different physical and chemical processes which have hitherto been announced, and he has found none which succeed so completely and so regularly.

Mr. Kitton writes * that whilst theoretically the method appears to be a good one he fears that it will not prove so effective, when much vegetable or animal matter is present, as the old sulphuric acid and chloride of potash process.

Mounting Sections in Series.—The use of shellac † for fixing sections on the slide, introduced by Dr. W. Giesbrecht, is a very valuable addition to histological methods, as hundreds of small sections may be arranged in serial order, and all inclosed in balsam under the same cover without danger of disarrangement. The method is further extremely useful in mounting larger sections, particularly those composed of loose parts, or parts liable to swim apart.

The shellac is prepared and used in the following manner:—One part of bleached shellac ‡ is mixed with ten parts absolute alcohol, and filtered. The slide is first warmed to about 50° C., and then a thin film of the shellac laid on by a glass rod drawn once over its surface. Before using, the slide is again warmed, and the shellac surface washed with oil of cloves for the purpose of softening it.§

* Sci.-Gossip, 1882, p. 257.

† MT. Zoolog. Station Neapel, 1881, p. 184. Cf. C. O. Whitman in Amer. Natural., xvi. (1882) pp. 783–4. Also this Journal, i. (1881) pp. 953–4.

‡ Dr. Mark uses the bleached shellac in the form in which it is prepared for artists as a "fixative" for charcoal pictures. It is perfectly transparent, and a film of it cannot be detected unless the surface is scratched. He attaches a small label to the corner of the slide, which serves for the number of the slide and the order of the sections, and at the same time marks the shellac side (otherwise not distinguishable).

§ Cf. this Journal, i. (1881) p. 953, where the following direction is given:—"Before commencing cutting, brush over the shellac layer very thinly with creosote, and then lay the section upon it with as little paraffin as possible."

The wash is made with a small brush drawn backwards and forwards until the entire surface has been moderately but evenly wetted with the oil.

Sections are now cut and arranged for the first cover; this done, the slide is warmed over a spirit-lamp so that the paraffin adhering to the sections melts and flows together, forming an even layer, which cools almost instantly, and thus secures the position of the sections while those of the second cover are prepared. The sections for the last cover having been completed, the slide is warmed for ten minutes on a water bath, in order that the sections may sink into the shellac and become fixed, and the oil of cloves evaporate. After allowing the slide to cool the process is concluded by washing away the paraffin with turpentine, and mounting in balsam dissolved in chloroform.

The following mode of fixing sections is described by Dr. J. Gaule*:—

The sections are cut dry and placed on the slide in the order and position in which they are to be mounted.

They are then smoothed out by the aid of a fine brush wetted in 50–60 per cent. alcohol, until all wrinkles are removed and every part is in close contact with the slide.

The slide is allowed to stand several hours (or over night) until the alcohol has completely evaporated, and the sections are left adhering quite firmly to the glass. The process may be hastened by gently warming to 45–50° C.

The paraffin may be removed by any of the solvents in common use, but xylol is recommended. A few drops are allowed to flow over the sections, and after a few moments the paraffin is fully dissolved.

The balsam (a mixture of balsam and xylol in equal parts) is placed on the cover-glass, and this allowed to sink slowly, from one side, over the sections.

Dr. Gaule finds it convenient, especially with serial sections, to use large cover glasses—often nearly as large as the slide itself. Thus a single slide may often contain a large number of sections closely arranged under one cover.

For large sections this method offers one important advantage over that of Dr. Giesbrecht; by the former all wrinkles may be removed, while by the latter the sections must lie as they fall. In the case of smaller sections, not liable to get wrinkled during the placing, Mr. Whitman † prefers the shellac method.

Eau de Javelle for Removing the Soft Parts of Preparations.‡—Dr. F. C. Noll has found eau de javelle (subchloride of potassium KC2O) very suitable for preparations of *Spongilla*, and for destroying the protoplasm in other objects.

If siliceous sponges are burnt or boiled in potash the hard parts, spicules, &c., separate, and are not shown in their proper

* Arch. f. Anat. u. Phys., 1881, Phys. Abthlg., p. 156. Cf. also this Journal, *ante*, p. 428.

† Loc. cit.

‡ Zool. Anzeig., v. (1882) pp. 528–30.

connection. To remedy this a piece of the sponge is placed on a slide covered with some drops of eau de javelle and left to stand with a glass over it, until all the soft parts are dissolved, which, in the case of thin sections, does not take more than 20–30 minutes. Gemmules take a longer time and should be left over night; their contents are dissolved without destroying the outer coat.

When the protoplasm is all dissolved the object is carefully treated with acetic acid which removes all precipitated matters, then with weak and afterwards with absolute alcohol. Finally oil of cloves (which in 15 minutes completely clears any cloudy gemmules) prepares the way for mounting in Canada balsam. The gemmules of *Spongilla fluviatilis*, *S. Lieberkühnii*, and *S. contecta*, from specimens which spread out on the under side of stones, remain *in situ* between the spicules, and give a perfect representation of the form of the sponge. In the more compact sponges, such as the free growing specimens of *S. Lieberkühnii*, the spicules remain united to the framework, although the lining and cementing substance has been dissolved. The layer by which the sponge is attached to its support, like the membrane of the gemmules, is not destroyed; it is not, however, turned black, like the latter, with a solution of nitrate of silver. These three elements of *Spongilla* have, therefore, a different chemical composition.

Diatoms are often found in the tissues of sponges, and these are as well prepared by the above process as they are after burning or boiling with sulphuric acid, so that eau de javelle is to be recommended as a very useful reagent for diatoms also.

To ascertain the effect on calcareous forms small mussel or snail shells (with or without epidermis) were laid in eau de javelle. They were clean and partly colourless but their lime remained uninjured. The same was the case with the calcareous bodies from the crust of different Gorgonidæ.

Small skeletons can be cleaned of skin, muscle, &c., without injuring the bones.

The liquid is also admirably adapted for cleaning vegetable sections. Potash and glycerine swell up the cell-walls or break up the preparations. In a quarter of an hour the sections are freed from all the soft parts and show only the clear cell-walls. After treatment with acetic acid they are mounted in Mayer's fluid (glycerine 1 vol., distilled water 2 vols., and to 10 vols. of this mixture 1 part salicyl-pyrogallic acid) or in gelatine-glycerine, balsam rendering the cell-walls too transparent.

Gum and Glycerine for Imbedding.*—L. Joliet has found that the soap which he was in the habit of using for imbedding, and which succeeded perfectly with the *Salpæ*, gave very bad results with *Pyrosoma*. It did not penetrate the common transparent substance which envelopes all the ascidio-zoids, so that they were rapidly distorted, and could not be cut. The following combination has, however, been of the greatest use:—

* Arch. de Zool. Expér. et Gén., x. (1882) pp. xliii.–v.

Dissolve in a little water some very pure gum arabic, so as to obtain a liquid having the consistency of a thick syrup.* Pour a little into a watch-glass, so as not to quite fill it. Then add from six to ten drops of pure glycerine, and with a small stirrer carefully mix the gum with the glycerine until it forms a homogeneous mass. Then lay the preparations on the surface of the liquid, and with needles press them into it.

This done leave the whole to dry, which takes from one to four days, according to the condition of the air. The gum will assume the consistency of cartilage; without being soft it is supple and yields to the finger. The cake of gum is then cut into squares or strips, corresponding with the preparations, and removed. A plate of gum enclosing the preparations is thus detached without difficulty from the bottom of the watch-glass. These plates are turned over and again allowed to dry until they are wanted for use; they may be preserved in good condition almost indefinitely, the gum, when mixed with a sufficient quantity of glycerine, never becoming hard or brittle.

The following are points to be noted:—Between the limits of 6 to 10 drops of glycerine above mentioned, the proportions most suitable to the nature of the object under examination and to the season of the year may be found by experimental trials. Too much glycerine prevents the gum from acquiring sufficient toughness, too little allows it to become brittle. In the winter or in rainy weather less glycerine should be added than in the summer or in dry weather. It is often well to soak the object in glycerine before putting it into the gum; the quantity of glycerine thus absorbed by the object being taken into consideration, and less added directly to the gum.

With a stove or by the help of the sun the gum can be very quickly dried, but in most cases it is a question of patience. It is one of the great advantages of the gum and glycerine that they dry so gradually; they are generally liquid the first day, pasty the second, and cartilaginous the third. The object having remained in this liquid for twenty-four hours is perfectly soaked, the gum having penetrated into all the interstices of the cells, and the sections preserve the relations of organs which are not directly connected. With soap or gelatine the imbibition is in many cases less perfect, because, unless a high temperature is maintained for a long time, the solidification of the mass takes place too quickly and does not allow the liquid to penetrate so deeply into the tissues.

When the strips are removed from the watch-glass, it is better to wait until they have assumed such a consistency that they cannot be easily bent. It is after having waited almost a week that the author has always obtained the best sections.

Gum alone rapidly becomes hard and brittle; the effect of the glycerine is to preserve it almost indefinitely in a cartilaginous consistency. Another advantage of the method is the perfect transparency of the substance surrounding the object to be cut, so that it

* Solutions of gum, sold under the name of strong white liquid glue, may also be used. They have the advantage of having a uniform consistency.

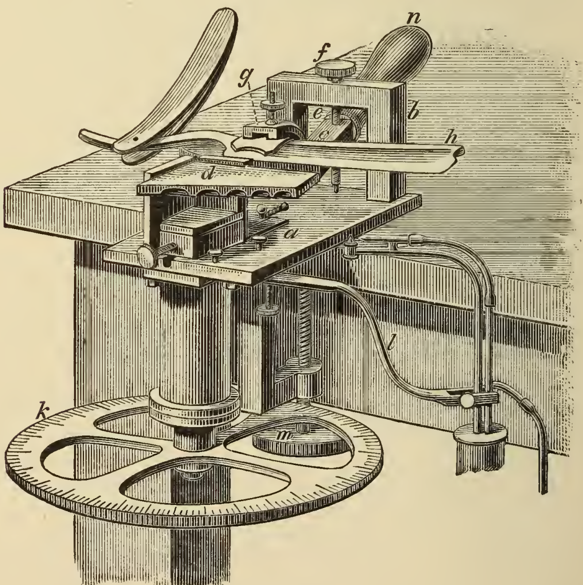
is easy to examine the preparation under the Microscope before cutting; the smallest details can be distinguished, and with a low power the object can be arranged very accurately, and the section can be made exactly through the desired point.

The sections being thus made, they are placed on a glass or a very dry surface, then taken up with a needle or fine moist brush and placed on the slide in a drop of water; the gum dissolves and leaves the preparation in place. A drop of glycerine placed at a corner of the cover-glass, quickly penetrates under it and replaces the water (which evaporates), and mixing with the melted gum, forms an excellent preserving liquid.

Roy's Microtome.* — Dr. C. S. Roy describes a microtome (Fig. 163) for cutting frozen or otherwise hardened substances.

The knife *h* is connected with the metal bar *c* by the clamp *g*. A small piece of leather laid on the back of the knife at the place where it is held by *g* enables the section to be made at any desired angle to

Fig. 163.

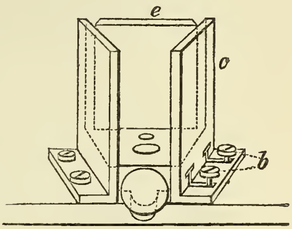


the horizontal. By a handle *n* the bar *c* can be moved on the pivot *e* furnished with the milled head *f*. The pivot passes through the support *b* which is attached to the base plate *a*. The knife is thus able to move over the object plate *d*, describing a circle on the pivot *e*. The object plate may be raised or lowered by *k*, and its under surface is deeply fluted, with the object of diminishing the thickness of the

* Arch. f. Mikr. Anat., xix. (1881) pp. 137–43 (1 pl.).

metal, and increasing the surface exposed to the ether-spray, which is applied by an arrangement of tubes supported by a rod *l*. The plate is large enough for pieces of tissue from 4 to 5 mm. by $2\frac{1}{2}$ mm. downwards.

Fig. 164.



General directions are added as to freezing and cutting which it is unnecessary to repeat here. Specimens otherwise hardened, however, Dr. Roy prefers to imbed in a mixture of wax and olive-oil shaped in a mould to fit in the frame (Fig. 164), which is made by removing the plate *d* and adding a third vertical plate *c*, which is fixed by the screws *b*. A spring presses the plate *e* forward so as to prevent any lateral movement of the imbedding mass. The microtome is fixed to the table by a clamp with a screw the head of which is seen at *m*.

Dr. Roy adds subsequently * that the essential points for which he claims novelty in this microtome are the peculiar structure of the object-plate to increase the surface exposed to the ether spray, and the improvement in the manner of attaching the knife.

Professor C. Weigert,† in preference to the English razor, employs the knives made by Härtel of Breslau or Frank of Leipzig, for making the sections, as having a perfectly level surface and not rubbing with the lower surface the object which is cut. By applying the sliding principle of the Rivet microtome he avoids the *pressing* action of the razor which, for soft specimens, is so undesirable—a *drawing* motion being thus substituted. He diminishes the area of the plate over which the razor travels by bending its sides somewhat down. When using the sliding principle the objects must not be frozen too hard. When sections have been made by the freezing plan they are examined fresh or in salt solution.

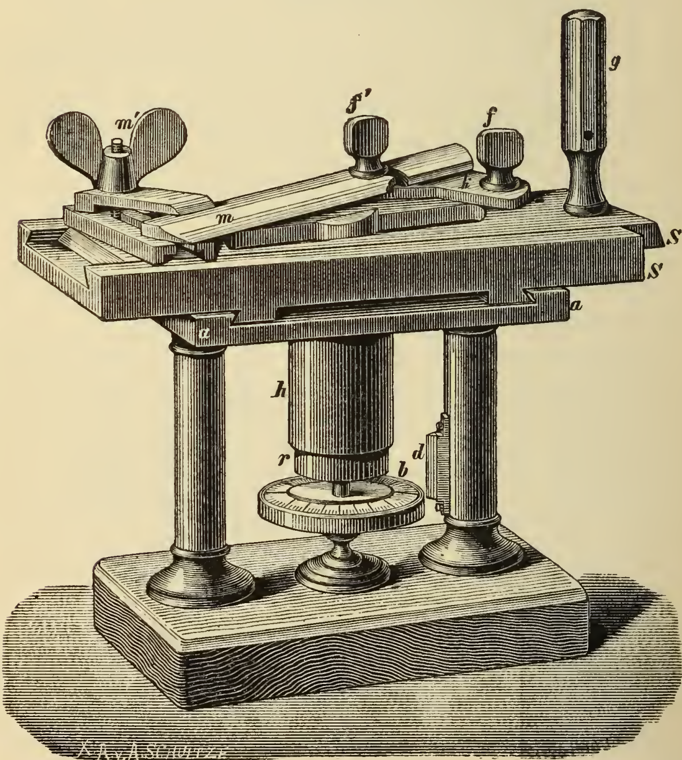
Boecker's Microtome with Automatic Knife-Carrier.‡—Although the microtome has now reached a high degree of perfection (writes E. Boecker) many defects still exist in the usual forms, as well as in those with sliding carriers for the knife. For this reason, perhaps, many still prefer free-hand cutting with the razor, although it is scarcely necessary to remark how little accuracy can be thereby obtained, and what inferior sections of often valuable material are turned out. The principal fault of the microtomes hitherto constructed, consists in the frequent tearing of cells or tissues, caused—at least in slide microtomes—by the fact that the knife is often wrongly placed and having only a forward movement, presses the object rather than cuts it. It is at least expected of a good microtome that with careful manipulation not a single section should be lost, a requirement of the utmost importance in series sections, or in

* Arch. f. Mikr. Anat., xix. (1881) pp. 527–8.
† Arch. Path. Anat. u. Physiol. (Virchow), lxxxiv. (1881) pp. 287–90.
‡ Zeitschr. f. Instrumentenk., ii. (1882) pp. 209–12 (4 figs.).

rare pathological injections, so that it should be possible to make extraordinarily thin sections without the least tearing of the cells or tissues. How far the thinness of the sections can be carried is, of course, different in different objects, and it is therefore difficult to lay down any hard and fast rules.

For the fulfilment of these requirements Boecker first endeavoured

Fig. 165.



to give to the knife the proper movement, so that it should move in the same way as if guided by the hand. It appeared to him that the ordinary method of moving the knife by means of a slide was not sufficiently firm, and involved the inconvenience of keeping the slide steady by the hand. He also decided to give the knife such a considerable inclination that it should be nearly parallel with the direction of the slide.

This attempt was successful in every respect. Two slides of brass-plate are connected in such a manner that their movements shall cross at right angles. If the one slide S′ (Fig. 165) is moved

longitudinally it must at the same time push the other slide S to the side. For this purpose S′ is provided with an oblique slit, in which the tube *h* slides backwards and forwards. The latter is attached to the plate *a*. The cylinder *r* serves for the reception of the object to be cut, and by means of the micrometer screw can be raised by hundredth parts of a millimetre, for which purpose a scale *b* with index *d* is added. The slide S has also a transverse slit, so that it does not come in contact with the tube *h*, and can move freely to a certain distance. The attachment for the knife is on the slide S′; the stability of the knife *m* is ensured by securing it in two places, first to the angle-piece *k*, which can be clamped in any position, and with the slide S′; and secondly by means of the screw *m′* which, with the piece belonging to it, moves in a slit as shown in the figure.

The slide S′ is moved by the handle *g*, and the oblique slit enclosing the tube *h* (see Fig. 166) causes the slide S to move in the

FIG. 166.

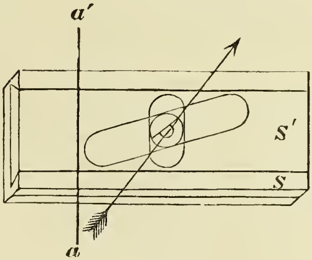
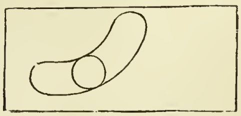


FIG. 167.



direction *a a′*, and thus effects a "drawing" movement of the knife. This movement is uniform if the slit is straight, as in the figure, and it can be effected quicker or slower according as the slit is more or less oblique. The drawing movement can also be accelerated during the cutting process; but in this case the slit must have a curved form, as in Fig. 167. The whole microtome must, however, be broader, although at the same time it may be shorter. By this arrangement the knife is able to cut in any oblique position.

In the microtome described the cylinder has a diameter of 25 mm., amply sufficient in most cases, but capable of being increased. For cases where it is preferred to use the knife with the hand, a circular glass plate is added to the slide S′.

Staining Bacillus tuberculosis.*—We have already described Dr. Koch's original process for detecting this *Bacillus* and Dr. Ehrlich's improvement upon it, as well as that of Dr. Van Ermengem.† Dr. H. Gibbes, referring to the unsatisfactory nature of the first two processes, says that the following simple process will bring out the bacillus with ease and certainty. It takes but a short time to carry

* 'Lancet,' ii. (1882) pp. 183–4. Brit. Med. Journ., No. 1137 (1882) pp. 735–6.

† See this Journal, *ante*, pp. 385, 572, and 706.

out, and the bacillus is stained so deeply and differentiated so fully from the surrounding substance that it can be seen with the greatest ease with an ordinary $\frac{1}{4}$-inch object-glass and daylight, the previous processes having stained it so faintly that high power or artificial illumination were required. The colours used are magenta crystals, which stain the bacillus, and chrysoidin, which stains only the surrounding substance. It is a brown which does not stain so intensely as vesuvin. The formulæ are:—

Magenta crystals	2 grammes.
Pure aniline	3 „
Alcohol (sp. gr. ·830)	20 ccm.
Distilled water	20 ccm.

Dissolve the aniline in the spirit, rub up the magenta in a glass mortar, adding the spirit gradually until it is all dissolved, then add the water slowly, while stirring, and keep in a stoppered bottle.

Make a saturated solution of chrysoidin in distilled water and add a crystal of thymol, dissolved in a little absolute alcohol, to make it keep; a dilute solution of nitric acid (coml.) is also required, one part of acid to two of distilled water.

The object of the process is to stain the sputum, or section, as the case may be, with a colour which the dilute nitric acid will remove from everything but the tubercle bacillus, and the subsequent staining with chrysoidin is only required to throw up the stained bacillus and make it more prominent. In Dr. Ehrlich's process, the stain for the bacillus is too faint, and the vesuvin, used to stain the ground substance, too opaque; consequently the bacillus appears a faint pink colour on a dense yellowish brown ground, and is not easily made out without high power or special illumination. His method of dissolving aniline in water, in which it is very sparingly soluble, is also open to objection, as it is very apt to vary in the amount taken up by the water.

For sputum the following process is the most simple. Spread a thin layer on a cover-glass and let it dry; when quite dry pass it two or three times through the flame of a small Bunsen burner and let it cool. Filter two or three drops of magenta solution in a watch-glass, place the cover-glass with the sputum downwards on the stain, taking care there are no air bubbles under it. Let it remain for fifteen or twenty minutes, then wash in the dilute acid until all colour has disappeared, remove the acid with distilled water, when a faint colour will return; then place the cover-glass in the same manner as before on a few drops of chrysoidin filtered into the bottom of a watch-glass, and let it remain a few minutes until it has taken on the brown stain; wash off the superfluous colour in distilled water and place the cover-glass in absolute alcohol for a few minutes, remove and dry perfectly in the air, place a drop of Canada balsam solution on the cover-glass and mount. It is better to use small glass funnels for filtering the stains, as they protect the fingers. Sections of hardened tissue are treated in the same manner with the necessary modifications.

With regard to the powers required to examine the bacilli after

they have been mounted by this process, an ordinary $\frac{1}{4}$-inch with daylight will show them perfectly, and a $\frac{1}{8}$ dry glass will show that they are rows of spherical bodies with the same illumination.

Brun, J.—Préparation des Diatomées. (Preparation of Diatoms.) [*Supra*, p. 887.] *Journ. de Microgr.*, VI. (1882) pp. 457–8.

„ „ Note sur les meilleurs procédés pour reconnaitre les bactéries de la tuberculose et en faire des préparations microscopiques. (Note on the best processes for showing the bacteria of tuberculosis and making microscopical preparations.) [*Post.*] *Bull. Soc. Belg. Micr.*, VII. (1882) pp. clxix.–lxxvii.
Journ. de Microgr., VI. (1882) pp. 500–3.

Bryan, G. H.—Pollen as a Polariscope Object.
[Pollen of *Godetia* polarizes "quite distinctly though not in a very marked manner"—also some others.]
Sci.-Gossip, 1882, p. 231.

Cole, A. C.—Studies in Microscopical Science.
No. 22 (pp. 161–4).—*Pilularia globulifera*. The Pillwort. Transverse section of stem, stained logwood. Plate × 149.
No. 23 (pp. 165–72).—The Lung. Vertical section Lung of Cat, injected carmine. Plate × 145.
No. 24 (pp. 173–6).—*Pilularia globulifera*. The Pillwort. Transverse section of sporocarp, unstained. Plate × 62·5.
No. 25 (pp. 177–84.)—The Thyroid Body. Transverse section of Human Thyroid Gland, stained carmine and sulph-indigotate of soda. Plate × 150.
No. 26 (pp. 185–96).—On the minute structure of the Sporocarp in *Pilularia globulifera*. The Pillwort. Dolerite of Dalmahoy Hill, Edinburghshire. Plate × 45, 65, and 150.
No. 27 (pp. 197–200).—The Thymus Gland. H.S. Thymus Gland of Calf, stained logwood. Plate × 65.
No. 28 (pp. 201–4).—Transverse section Thallus of Lichen. *Sticta pulmonacea*. Plate × 400.
No. 29 (pp. 205–8).—The Pancreas. Transverse section of Human Pancreas (part of a lobule), stained carmine. Plate × 333.

Davis, G. E.—The Dust from Boiler Flues under the Microscope.
[Describes principally the minute spheres found on the bottom and sides of the flues.]
North. Microscopist, II. (1882) pp. 316–7.

Egeling, G.—Ueber die Anfertigung Mikroskopischer Präparate in der Pharmacie. (On making Microscopical Preparations in Pharmacy.)
Deutsch-Amerikan. Apotheker-Ztg., New York, 1882, Nos. 13 and 14.

Flesch, M.—Kleine Mittheilungen zur Histologischen Technik.
[1. Employment of Iodine-green and Methyl-green, *supra*, p. 883.
2. Monobromide of Naphthaline as a Mounting Fluid, *post.*]
Zool. Anzeig., V. (1882) pp. 554–6.

Fredericq, L.—Note sur les préparations anatomiques sèches à l'essence de térébenthine. (Note on dry anatomical preparations with oil of turpentine.)
[Claim of priority (by 6 years) in publication of the method over Dr. Riehm and Professor Semper. Cf. I. (1881) p. 706, and *ante*, pp. 705–6.]
Zool. Anzeig., V. (1882) p. 588.

Geikie, A.—A search for "Atlantis" with the Microscope. [*Post.*]
Nature, XXVII. (1882) pp. 25–6.

Gibbes, H.—An Easy Method of Detecting *Bacillus tuberculosis* for Diagnostic Purposes. *Lancet*, II. (1882) pp. 183–4.

„ „ A New Method for the Detection of the Tubercle Bacillus.
Brit. Med. Journ., No. 1137 (1882) pp. 735–6.

„ „ Further Remarks on Staining *Bacillus tuberculosis*.
[*Supra*, p. 895.]
„ „ No. 1138 (1882) pp. 786–7.

Harrison, J.—Report of Lecture on Mounting Microscopical Objects.
[Various receipts and directions.]
1st Journ. and Rep. Braintree and Bocking Micr. and Nat. Hist. Club, 1882, pp. 9–10.

Heron, G. A.—Ehrlich's Method for the Detection of Tubercle Bacillus in Sputum. *Brit. Med. Journ.*, No. 1137 (1882) p. 735.

Hitchcock, R.—Mounting Histological Specimens.
[Remarks on T. C. White's paper, *ante*, p. 438, and on mounting in fluids of various refractive indices.]
Amer. Mon. Micr. Journ., III. (1882) pp. 198–9.

Kitton, F.—Talc.
[Rarely used now for permanent preparations—sometimes substituted for selenite in polariscopes but not satisfactorily.]
Sci.-Gossip, 1882, p. 232.

„ „ Preparation of Diatoms.
[Translation of and Note on Professor L. J. Brun's paper. *Supra,* p. 887.] *Sci.-Gossip,* 1882, p. 257.

Lewis, B.—On the Methods of Preparing, Demonstrating, and Examining Cerebral Structure in Health and Disease.
Brain, Jan. 1881, p. 502, April 1881, p. 82, Oct. 1881, p. 351, Jan. 1882, p. 441, and April, p. 74.

Libbey, W., jun.—A New Form of Constant Pressure Injection Apparatus. [*Post.*] *Amer. Mon. Micr. Journ.*, III. (1882) pp. 187–9 (1 fig.).

M., C. J.—The Preparation of Dammar Varnish for Microscopic Purposes.
[*Post.* Containing also directions for a substitute for Canada balsam made by gently evaporating copal varnish and adding pure benzole.]
Sci.-Gossip, 1882, p. 257.

Maplestone, C. M.—Observations on Living Polyzoa.
[Contains note as to finding living specimens washed up on the beach. *Post.*]
Trans. and Proc. Roy. Soc. Victoria, XVIII. (1882) pp. 48–51 (1 pl.).

Martin's (the late John, of Maidstone) Unmounted Objects.
[Notice that the unmounted material from his laboratory has been forwarded to Rochester, N.Y., for sale.]
Amer. Natural., XVI. (1882) p. 931.

Mayer, S.—Beitrag zur histologischen Technik. (Contribution to Histological Technic.) *SB. Wien. Akad.*, LXXXV. (1882) pp. 69–82 (2 pls.).

Meyer, H. v.—Modificirte Form der Kleisterinjection. (Modified form of Paste Injection.) *Arch. f. Anat. u. Physiol.* (*Anat. Abth.*) 1882, pp. 60–1.

Minor, —.—Ueber die combinirte Palladiumchlorid-Carminfärbung zur pathologischen Untersuchung der Centralnervensystems. (On Chloride of Palladium and Carmine for Pathological Researches on the Central Nervous System.)
Centrabl. f. d. Med. Wiss., 1882, p. 38.

Mounting Classes, Microscopical.
[Notice of the opening meeting of the present session of the Manchester Microscopical Society.]
North. Microscopist, II. (1882) p. 322.

Moyret, M.—Micrographic Study of Dyed Silks.
Chem. Review, XI. (1882) p. 203, from *Teinturier Pratique.*

Neelsen & P. Schiefferdecker. Beitrag zur Verwendung der ätherischen Oele in der histologischen Technik. (Contribution to the use of Ethereal Oil in Histological Technic.) *Arch. f. Anat. u. Entwicklgsg.*, 1882, pp. 204–6.

Noll, F. C.—Eau de Javelle als Mittel zum Entfernen der Weichtheile aus Microscopischen Präparaten. (Eau de Javelle as a means of removing the soft parts of Microscopical Preparations.) [*Supra*, p. 889.]
Zool. Anzeig., V. (1882) pp. 528–30.

Olivier, L.—Les Procédés Opératoires en Histologie végétale. (Practical Processes in Vegetable Histology.) (*Concld.*) [*Post.*]
Rev. Sci. Nat., II. (1882) pp. 71–91.

Randall, B. A.—An Economical Cabinet for Microscopical Slides. [*Post.*]
The Microscope, II. (1882) pp. 134–5, from *Western Medical Reporter.*

Renard, A.—Description lithologique des Récifs de St. Paul. (Lithological description of the Rocks of St. Paul. [See *supra*, Geikie, A.]

Sep. Repr. Ann. Soc. Belge Micr., 1882, 53 pp.

Richter, P.—Préparations Microscopiques d'Aphidiens. (Microscopical Preparations of Aphides.)

[List of 34 genera with number of species.]

Journ. de MicrL., VI. (1882) pp. 472–3.

Seiler, C.—Remarks on Grinding Knives for Cutting Thin Sections.

[At the Montreal meeting of the Amer. Assoc. Adv. Sci. he stated that after considerable experience in grinding knives for cutting thin sections, he had found that the bevel of the edge should be the same on the two sides, and he explained a device which enabled him to ensure the true bevel without difficulty.]

Amer. Mon. Micr. Journ., III. (1882) p. 200.

Simms, J.—A Collier's Experience of Section-cutting.

[Jocular story of an attempt to soften coal in carbonate of potash.]

Sci.-Gossip, 1882, p. 227.

Szyszylowicz, I.—Korallina jako odczynnik mikrochemiczny w histyjologii ros'linnéj. (Corallin as a micro-chemical reagent in vegetable histology.) [*Post.*]

Osobne odbicie z Rozpran Akad. Umiej. w Krakowie, X. (1882) 18 pp.

Cf. Abstract in *Bot. Centralbl.*, XII. (1882) pp. 138–9.

Whitman, C. O.—Methods of Microscopical Research in the Zoological Station in Naples—*concluded.*

[Translation of P. Mayer's article, *ante*, III. (1880) p. 551. *Supra*, p. 866.]

Amer. Natural., XVI. (1882) pp. 772–85 (5 figs.).

Wood, J. T.—Manipulation.

[Taking up cover-glasses by suction through a glass tube ending in a small piece of rubber tubing. Also small and light objects by a glass tube drawn out to a very fine point with the smallest conceivable hole through it.]

North. Microscopist, II. (1882) p. 321.

OBITUARY.

The following Obituary notices were read by the President in his Address, *ante*, p. 145:—

Chas. Joseph Hyde Allen, F.L.S., F.G.S., F.Z.S., was elected in 1859 and appointed Treasurer of the Society at the Annual Meeting in 1862, but failing health compelled him shortly afterwards to leave England. Mr. Allen died 20th March, 1881, aged 62.

Sir Antonio Brady, Kt., J.P., F.G.S., F.M.S., F.A.S.L. (elected in 1854, died 12th December, 1881), was the eldest son of the late Mr. Anthony Brady, of the Royal William Victualling Yard, Plymouth, by his marriage with Marianne, daughter of Mr. Francis Perigal. Born in 1811, he entered the Civil Service of the Navy as a junior clerk in the Victualling Yard, Deptford, more than fifty years since. After serving in various offices, he became head of the Contract Office and Registrar of Public Securities in 1854, subsequently assisting to reorganize that office. He was subsequently appointed first superintendent of the Purchase and Contract Department, retiring from the service in 1870, when he received the honour of knighthood. After his retirement, Sir Antonio took a leading part in the preser-

vation of Epping Forest for the people, and was appointed a judge in the "Verderer's Court for the Forest of Epping." He was a great and able collector of the osseous remains of the great post-pliocene mammalia, and was a member of the Geological and other Societies. He married, in 1837, Maria, eldest daughter of the late Mr. George Kelner, of Ipswich, by whom he leaves a son, the Rev. Nicholas Brady, M.A., and two daughters.

Richard Clewin Griffith, M.R.C.S., F.R.G.S., F.Z.S., M.R.I. (elected in 1855, died 5th September, 1881), had at the time of his death attained the great age of ninety years (less three days). He passed his examinations in 1812 and 1813, and was among the first batch of "general practitioners." He took his father's practice, in Tottenham-court-road, then a country suburb of London, and after a few years removed to Gower-street. He is described as having "belonged to the old school of practical medicine, and despised theories." He was the father of the Apothecaries' Society, of which company he was the Master about twenty-six years ago. For several years the late Mr. Charles Brooke, of the Westminster Hospital, was his partner.

William Moginie (elected 1866, died 13th December, 1881, aged 53). Mr. Moginie from early youth took great interest in microscopical and other scientific pursuits, and as an amateur was one of the first to produce micro-photographs, some of which have never been surpassed. He also made several improvements in the instrument, the chief being the 'Moginie Travelling Microscope,' one of the most convenient of portable Microscopes. Besides being well known as a practical optician, possessed of great mechanical ingenuity, Mr. Moginie was especially noted as a demonstrator, there being few who could exhibit an object with equal skill as regards definition and illumination. Microscopists have lost a prominent and valued member, and his considerable circle of acquaintances a kind and warm friend.

James Tennant, F.G.S., F.C.S., F.M.S., F.Z.S., was one of the original Members of the Society, having been elected in 1840. He was for many years Professor of Geology and Mineralogy in King's College, London, and subsequently held the Mineralogical chair. He was Mineralogist to the Queen, and a Fellow of many of the learned societies, and was highly appreciated as a mineralogist. He formed a large collection of minerals, and took a great interest in science generally, endeavouring to connect one of the City companies with the movement in favour of technical education.

PROCEEDINGS OF THE SOCIETY.

Meeting of 11th October, 1882, at King's College, Strand, W.C., The President (Professor P. Martin Duncan, F.R.S.) in the Chair.

The **Minutes** of the Meeting of 14th June last were read and confirmed, and were signed by the President.

The **List of Donations** (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Dippel, L.—Das Mikroskop, &c. 1er Theil, 1e Abtheil. 2nd ed., viii. and 336 pp. and 189 figs. (8vo. Braunschweig, 1882)	*The Author.*
Dodel-Port, A. and C.—Anatomisch-physiologischer Atlas der Botanik. Part 6	*The Authors.*
English, J. L.—A Manual for the Preservation of the larger Fungi, &c. viii. and 41 pp. (8vo. Epping, 1882) ...	*Mr. Crisp.*
Micrographic Dictionary. 4th ed. Parts 13–15	*Mr. Van Voorst.*

Mr. Stewart called the special attention of the meeting to Dr. Dodel-Port's diagrams (in continuation of the series), which were not only executed with admirable effect, but were also exceedingly correct and of great use for the purposes of the lecture-room.

Mr. Beck exhibited a slide of *Bacillus tuberculosis* prepared by Dr. H. Gibbes by the new process he had devised (see p. 895).

Mr. Beck also exhibited and described a new "Lithological Microscope" (see p. 847).

Mr. Stewart thought that whilst there were many admirable points about the instrument, yet that, in use, the movement of the polarizing prism might work loose in course of time through being on a hinge joint, and he suggested that it would be found an improvement to have an arrangement shifting in a plane parallel to the stage.

The President said that the subject which Mr. Beck's Microscope was intended to facilitate—now known as Petrology—was a branch of geology which was of extreme interest and importance, and which had made gigantic strides in recent years, so that there were now many geologists who confined their attention to the examination of rock sections. In the course of such observations, the constant shifting of the prisms was extremely tedious, and some remedy for this was indispensable. The important question was, which of the various methods was the easiest? In looking at the instrument as it stood, he thought that the necessary movement could be effected more easily as Mr. Beck had constructed it than by a lateral movement as suggested by Mr. Stewart. This branch of geological study was, he considered, a most desirable one for the Fellows to take up. It in-

volved a study of optics as well as of geology. There was an idea that such observations could be carried out better elsewhere than in this country, where they first originated; but he thought that, with the aid of Mr. Beck's improvements, there would be no difficulty in showing that we were able to investigate the subject, at least as well as could be done anywhere else.

Mr. Crisp exhibited and described (1) Gundlach's College Microscope (see p. 670); (2) Boecker's Air-Pump Microscope; (3) The Bausch and Lomb Optical Company's Immersion Illuminator (see p. 688) (the latter not, however, being 1·52 N.A. as marked, but about 1·20 N.A.); (4) Thomas' Vivarium (see p. 688); and (5) a new achromatic spherical pocket lens, by Gundlach ("Globe lens"), which consisted of a sphere of crown glass enclosed in an outer sphere of flint glass.

Mr. Ingpen described a method of rapidly attaching objectives to the nose-pieces of Microscopes which had been devised by Mr. E. M. Nelson, the idea having been suggested to him by the method employed by the French for fixing the head-pieces of ordnance (see p. 858).

Dr. Ondaatje, of Ceylon, was introduced to the meeting by the President, and exhibited and described a number of specimens of Echinoderms, Gorgonidæ, Algæ, &c., which he offered to the Fellows for mounting.

The President, in thanking Dr. Ondaatje for his communication, said that a small specimen of *Echinus* was especially curious, as it seemed to him it did not consist of the original carbonate of lime of the creature, but looked more like crystallized calcite, as if it had been concreted in some way.

Mr. E. W. Burgess's letter was read, accompanying specimens of diatoms from the Island of Lewis (see p. 665).

Mr. Crisp said it would be in the recollection of the Fellows that, at the April meeting of the Society (see p. 440), a note by Drs. Loew and Bokorny was read, as to the chemical difference between living and dead protoplasm, and that some remarks were made by Mr. Stewart as to the possibility of some of the effects being due to the remains of the citric acid used in killing the protoplasm. Dr. Loew had since written a note in reply to the criticisms, which was then read as follows:—

"I learn from the June number of your highly-esteemed journal that the discovery of a chemical difference between living and dead protoplasm by myself and Bokorny has given rise to some discussion in the Society. Mr. Stewart has expressed some doubts in regard to our statement, believing that some residual citric acid (which we had applied in one case of killing the cells) might have been the cause that no silver was reduced.

In regard to this I have to say that the acid was removed as well as possible by continued washing with distilled water, before applying the silver reagent. Besides, the *alkaline* nature of the latter would have neutralized any trace of the acid left. The reason why, after killing with citric acid, no more silver was reduced by the cells, was certainly a chemical change of the protoplasm itself.

Whoever will take the trouble to study our publication, 'Die Chemische Kraftquelle im lebenden Protoplasma (The Chemical Source of Power in the living Protoplasm), will find that every precaution was taken in all our labours to avoid errors and false conclusions. We have killed the cells in all possible ways: by starvation, by desiccation, by heating to 50° C., by mechanical action, by electrical sparks, by ether, alcohol, carbonic acid, kerosene, sulphuretted hydrogen, by sugar, tannin, by acids, alkalies, and salts; and in all these cases the protoplasm had become changed, so as to be incapable of reducing silver. In one case, however, death was produced by destruction of the structure and organization *alone*, the chemical nature remaining unchanged; it was by the action of certain poisons, especially alkaloids. We have described these cases in minute detail in our publication.

Life must be considered as the result of two functions:—

1. Of a specific chemical motion—viz. the energy of the aldehydic groups in the molecule of the *active* albumen.

2. Of the organization of the protoplasm—viz. the specific molecular construction from molecules of active albumen. If *one* of these functions is destroyed, death is the result (see pp. 25 and 77 of our publication).

No thinking mind will doubt that the vital force is a mode of motion, like all other forces of nature. We have proved beyond a doubt that the vital force is the result of a specific *chemical* motion, as minutely explained in our publication (see pp. 19–25 and 88).

It is true there are many objects which are so sensitive, that they die too quickly to give the silver reaction, which is only slowly developed, requiring many hours; we have described such cases too (see pp. 60–62 of our publication).

I have proved, furthermore, that the *quantity* of reduced silver corresponds with my theory (see pp. 91, 92), and have arranged now to analyze the product formed by the action of the silver solution upon the living protoplasm; a product that it is impossible to obtain with dead protoplasm.

In regard to Mr. Stewart's remarks on 'silver-staining,' it is most essential to note that the silver-staining process is based *upon the action of light;* many organic substances will reduce silver, *if in contact with light. Our process, however, goes on in absolute darkness!* and is quite a different thing from the 'silver-staining process.'

Recently some volatile aldehydes have been discovered in plants by Mori and by Reinke; but we must utterly deny that our observation has anything to do with such an aldehyde. Our objects were entirely free from any volatile or soluble aldehyde; hence our reaction shows conclusively *the aldehydic groups as constituent parts of the molecule of active albumen.* The albumen, passing from the active

into the passive condition, loses the *aldehydic groups* by displacement of the atoms ('Atomumlegerung') and the intense chemical motion has ceased herewith at once."

Mr. Stewart said that the remarks which he made on the occasion referred to were hardly offered as a matter of criticism, but rather by way of inquiry. It was clear that the experiments of the authors had been conducted with singular precision, and he was very glad that his observations had been the means of bringing out these additional particulars. He might also say that the original paper of Drs. Loew and Bokorny having been sent to him, he had laid it before Dr. Bernays, the chemical lecturer at St. Thomas's Hospital, who had been so much interested in the subject that he intended to thoroughly investigate it, and no doubt they would in due course hear the results of his experiments. Meanwhile, as a preliminary, he had received from him the following letter:—

"I have read the letter of Drs. Loew and Bokorny, and consider as proved by them that the power of producing alkaline silver solutions is an essential property of many forms of living vegetable plasma. I consider that a complete answer is furnished to your own suggestion about residual citric acid: that must be given up. The experiments of Drs. Loew and Bokorny have been made with a care and skill deserving of the highest praise.

Of the nature of animal protoplasm little is known. The authors of 'Die Chemische Kraftquelle im lebenden Protoplasma' admit as much; but they consider themselves entitled to the judgment that the reactions of aldehyde groups in active albumen are capable of equal application. The cases of chronic silver-poisoning do not seem to confirm the view, as we should certainly expect on the aldehydic theory a much more even distribution of metallic silver. And, in the case of man, alcoholic potations would have to be rigidly excluded in order to *assist* in the confirmation, or otherwise, of the aldehydic theory. Whether any, and what, differences exist between vegetal and animal albumens we cannot exactly say.

The aldehydic theory is the most interesting attempt at explaining the distinction between living and dead protoplasm that has ever been offered. But, although the reactions discovered by Drs. Loew and Bokorny are similar, *in the one aspect of reducing alkaline silver solutions*, I do not see more in their most interesting statements of experiments and views than to confirm most successfully the difference between living and dead plasma. For myself, I say, with all deference to these distinguished scientists, that further proof must be offered of the view these gentlemen hold, before I would accept the aldehydic theory as more than an interesting attempt at explanation."

Mr. Crisp read a note from Mr. C. Stodder as to the Tolles $\frac{1}{4}$-inch objective with tapering front, exhibited at the June meeting (see p. 589), in which the writer pointed out that the speakers at that meeting, who stated that "similarly tapered" objectives had been made as early as 1848 by Andrew Ross, and since by others, had not understood "the peculiarity or the purpose of the construction of the

objective exhibited. It is not merely an objective of the usual form in a tapering or conical brass mount, but the front lens is itself a cone." No such objective had ever been seen in America previously to that first made by Tolles in May 1870, and there is no record of any having been made in England or anywhere else.

Mr. Ingpen said he was now able to exhibit the objective he referred to at the last meeting by Andrew Ross. Its aperture was 60°, and the front lens, which was a triplet $\frac{3}{10}$ inch in diameter, was coned down to an angle of 120°, reducing the front to $\frac{1}{10}$ inch surface. Opaque objects could be illuminated at an angle of 30° from the level of the slide. The primary reason for coning this particular objective was the use of a very narrow Lieberkühn, but objectives were also coned for the purpose of getting rid of "stray light," to which particular attention was afterwards called in an article by Mr. Wenham on angular aperture, published in 1874, after which many lenses were coned for that purpose. The practice had since been to a great extent abandoned, in consequence of the reduction of aperture caused by it.

Mr. Beck said it was quite preposterous for any one to suggest that there was any novelty whatever about the objective referred to by Mr. Stodder. James Smith, who was a very skilful worker in glass, used to pride himself upon the way in which he was in the habit of coning down object-glasses. He used to fit them in a cell, and then turned them down in a lathe with a diamond, so that the front lens had no cell at all. A small brass cap was fitted over it to prevent any danger of its being injured.

Dr. Edmunds said that the Fellows always cordially welcomed communications from foreign microscopists. It was true that it had been demonstrated this evening that the idea of coning off the front lens of an objective had been tried long since by English opticians, and therefore that the plan communicated by Mr. Stodder was not new; but he thought Mr. Tolles was evidently entitled to the merit of an independent invention. These discussions over devices tried and lost sight of, only to be reinvented a generation later, showed the value of the figures and technical descriptions of apparatus which had been published in the Society's Journal of late years. He asked if Mr. Beck or Mr. Ingpen could give the meeting any references to previous descriptions of the method.

Mr. Beck said it was recorded in the catalogues of their firm; and if any other evidence was needed, it might be found in the fact that a large number of microscopists were in possession of similar objectives. Mr. Beck then examined the Society's Cabinet, and produced one of James Smith's objectives, made before 1847, the front lens of which was coned off in the manner described, and a small cap put over it.

Mr. J. Mayall, jun., said he understood Mr. Stodder's claim on behalf of Mr. Tolles to be that he originated the plan of reducing the front lens or lenses of an objective, as near as possible to the cone of light transmitted, so that the exposed surface of the front lens was the exact working diameter required for the aperture of the whole combination. By such acute coning no doubt the greatest range was

provided for the use of Lieberkühns, &c. He had examined many low-power objectives with tapering fronts, but the great majority were seen at a glance to have been coned with no other purpose in view than to improve their appearance. With regard to the Ross $\frac{1}{2}$-inch objective of 60° air-angle, exhibited by Mr. Ingpen, of which the body of the front lens was coned to an angle of 120°, it was evidently not Andrew Ross's intention to cone the front to the uttermost, or he would have cut it down to an angle of about 40° instead of 120°: 40° in the body of the crown-glass front being sufficient to transmit a pencil of 60° from air. Could Mr. Beck affirm that the objective he referred to, made before 1847, was coned in front so as to allow just the full aperture to be utilized? If so, he (Mr. Mayall) thought Mr. Stodder's case must fall to the ground.

Mr. Beck said that the one he held in his hand was done with the precise object of getting the front reduced to the smallest cone possible.

Dr. Dippel's note "Correction-Adjustment for Homogeneous-Immersion Objectives," was read by Mr. Crisp (see p. 854).

Mr. Beck said that the paper seemed to him to be an apology for being content with inferior definition rather than taking the trouble to get the best that was to be obtained. He understood the course of argument to be that there was so much trouble in making the adjustment that it was better to do without it. He ventured to say that there was not any one who had got over the trouble who would for a moment put up with what was inferior, if he had it in his power to get what was the better. He should like to hear some observations on this subject from Mr. Mayall.

Mr. Crisp said that the author of the paper did not put the matter on the ground of trouble at all. What he said was that the advantages to be derived from the adjustment-collar were so infinitesimal in the case of unknown objects, that they did not compensate for the disadvantages.

Mr. Ingpen thought that even amongst those who were thoroughly familiar with the use of the highest powers, very few would be found capable of adjusting an objective to the same degree of accuracy as the optician, and therefore any one who had a valuable objective should be very careful not to disturb its correction. It was also, he believed, a matter of experience that with the particular class of objects referred to by Dr. Dippel, no two histological observers would agree as to the best correction. Professor Abbe had met that difficulty by proposing a special test-object for the purpose, and as the description of this method would, he understood, shortly appear in the Journal, he need not enter further into that part of the subject, except to say that the Professor's test-plate was not like the *Podura* scale or *P. angulatum*, but showed beyond question what the best correction was, and made it possible for a person to pass a number of objects under the objective, and at once determine the best correction for each.

Mr. J. Mayall, jun., said he concurred in much that Mr. Beck had

said, especially in his advocacy of all that tended towards the perfection of objectives. As regarded the application of the correction-adjustment to homogeneous-immersion objectives, he was obliged to express his disagreement with Dr. Dippel. The facts on which his own judgment on this question was based were briefly these:—When Zeiss's homogeneous-immersion objectives were first sent to England, he immediately observed that certain dry objects, such as *Podura*, were very indifferently defined by the new lenses, precisely as he had previously found with water-immersions in fixed settings. These objects were always such as did not adhere very closely to the cover-glass. Knowing from experience that the correction-adjustment had, in many cases, met the difficulty with water-immersions, he took an early opportunity of pressing upon Messrs. Powell and Lealand to apply the adjustment to the homogeneous-immersions. The result fully answered his expectations. There could be no doubt whatever that the correction-adjustment increased the range of conditions within which the homogeneous-immersions would give fine definition. He might state, as a matter of repeated personal experience, that in testing a number of homogeneous-immersions—fixed settings *versus* adjustment settings—whilst there were undoubtedly many preparations which were defined equally well by both systems, there were also many upon which no superficial structure could be discerned with the objectives in fixed settings, but which yielded well-defined images when viewed with objectives having the correction-adjustment. The differences in the lenses might not be so marked as those seen in comparing dry lenses with and without adjustment; but still they were unmistakable, and unquestionably in favour of the adjustment. In the best homogeneous-immersion objectives he had examined, the corrections were so sensitive that different thicknesses of cover-glass had to be compensated for by the adjustment; whilst different specimens of oil of cedar-wood so completely altered the character of the image, that unless the correction-adjustment were brought into use, the objective might be condemned as defective. Even with the correction-adjustment, a marked variation from the normal immersion-fluid could not be compensated for. The objectives he here referred to were those of apertures from 1·2 to 1·47. He could not agree with Mr. Ingpen that it was best for the amateur to let the opticians choose for him the best average adjustment, and there fix the lens-mounting. He considered the amateur should make himself skilled in the use of the adjustment. As to the difficulty of finding two persons who would agree on the best point of adjustment in attempting to interpret an image of an histological preparation, he thought the solution of the difficulty would be best found by ensuring greater skill in making the preparation. When the *Bacillus tuberculosis* was first observed, it was only after great perseverance that anything could be interpreted from the confused mass of images; but the moment better methods of treating the preparations were found, the difficulties vanished, and what had formerly required hours of patient investigation to glimpse was now exposed to the eye at a glance. It would be interesting to the Society to learn that Prof. Abbe himself had so far wavered from his former opinion against the application of the cor-

rection-adjustment to homogeneous-immersions that he now agreed with Dr. Zeiss that those objectives should be supplied either with or without adjustment; accordingly, in future, both kinds would be supplied. He gave this on the authority of Dr. Zeiss. Prof. Abbe must therefore be regarded as partially, at least, opposed to Dr. Dippel's views. He might add that, among the opticians who were in favour of mounting homogeneous-immersions with correction-adjustment, were Powell and Lealand, Ross, Schroeder, Spencer, and Tolles.

Mr. Crisp said that Dr. Dippel did not dispute that a somewhat higher degree of accuracy might be obtained with the correction-collar, but it was only with known objects, such as the Abbe test-plate, and with the closest examination. With unknown objects, however, he considered it was utterly impossible to determine the position of best correction, and the correction-collar had, therefore, in those cases, no advantage to compensate for its disadvantages, and should not be used by histologists at any rate.

Mr. Crouch said that, in making the rough adjustments for students' Microscopes, they had to bear in mind the purposes for which they were likely to be used. In ordinary cases they would have to provide for histological sections, and this was not an easy matter, being quite unlike the case of a *Podura* scale, where they could adjust properly, because they had a surface to focus upon. He found the best average results were obtained from an objective when it was adjusted for an average thickness of cover-glass. He had known cases in which objectives with correction-collars had been condemned and returned to him, because it was said that good definition could not be got, the same objective being pronounced satisfactory after being remounted in a fixed setting.

Dr. Edmunds thought that adequate weight had not been given to the difficulty of ascertaining what was the true image of a complex histological section when viewed under a high-power objective. The real question was whether that image could be most certainly fixed upon by means of a lens furnished with a correction-collar, necessitating its adjustment for each object. Microscopists who devoted themselves to the resolution of *Amphipleura pellucida*, or of Nobert's lines, often knew nothing of the difficulty of interpreting the structure of muscular fibre and other more complex histological objects. The *Podura*-scale, though used as a test-object for histological lenses by their makers, yet was an object whose structure had never yet been interpreted in any way which commanded general assent. Take, again, *Pleurosigma formosum* in balsam, which presented different appearances with every touch of the correction-collar and with every variation in focal distance, so that it could not be interpreted with certainty; were a skilled microscopist now to see this object for the first time, a correction-collar upon his homogeneous lens would only add to his difficulties in fixing upon what was its true image. With a water-lens and varying thickness of cover-glass, the case was different, and the correction-collar was indispensable. While, therefore, the correction-collar might be theoretically an advantage, he thought that in practice it would be a disadvantage, and that, instead

of attempting to correct the objective, we should correct the object by mounting it always under conditions defined as those of homogeneous immersion.

Mr. Guimaraens called attention to a slide labelled "Pedicellariæ in situ, attached to the spine of *Echinus gracilis*," and sold as illustrating a discovery that pedicellariæ are attached to the spines of *Echini*. He would be glad to know whether the pedicellariæ in question were naturally attached to the spine, or whether an imposition had been practised.

Mr. Stewart said that in this specimen the pedicellariæ were undoubtedly adherent; but they could not have been so during the life of the animal.

The following Instruments, Objects, &c., were exhibited:—

Mr. Beck:—(1) Slide of *Bacillus tuberculosis* prepared by Dr. H. Gibbes. (2) New Lithological Microscope.

Mr. E. W. Burgess:—Diatoms from the Island of Lewis.

Mr. Crisp:—(1) Gundlach's College Microscope. (2) Boecker's Air-pump Microscope. (3) The Bausch and Lomb Optical Co.'s Immersion Illuminator. (4) Thomas's Vivarium. (5) New Achromatic Spherical Pocket-lens by Gundlach ("Globe lens").

Mr. Guimaraens:—Slide labelled "Pedicellariæ in situ attached to spine of *Echinus gracilis*."

Mr. Ingpen:—(1) Nelson's Nose-piece Adapter. (2) Objective of Andrew Ross with tapering front.

Drs. Loew and Bokorny:—Twelve slides illustrating their views on the chemical difference between dead and living protoplasm.

Dr. Ondaatje:—Specimens of Echinoderms, Gorgonidæ, Algæ, &c.

MEETING OF 8TH NOVEMBER, 1882, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (PROFESSOR P. MARTIN DUNCAN, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 11th October last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Braithwaite, R.—The British Moss Flora. Part 6	*The Author.*
Deby, J., and Kitton, F.—A Bibliography of the Microscope and Micrographic Studies, being a Catalogue of Books and Papers in the Library of J. Deby. Part 3. The Diatomaceæ	*Mr. Deby.*
Saurel, L.—Du Microscope au point de vue de ses applications à la connaissance et au traitement des Maladies Chirurgicales. 148 pp. (8vo. Paris, 1857)	*Mr. Crisp.*
Six slides of ovaries, &c., of plants	*Mr. Krutschnitt.*
Five slides of Diatoms mounted from the materials sent by Mr. W. F. Petterd from Tasmania	*Mr. Kitton.*

Mr. Collins exhibited a portable form of his histological Microscope, the special feature of which was the folding-up of the heel-piece of the tripod.

Mr. Curties exhibited several of Zeiss's pocket and dissecting microscopes.

Mr. Crisp exhibited and described (1) Guillemare's School Microscope (see p. 669) and (2) Prof. Abbe's Refractometer, for readily ascertaining the refractive index and dispersive power of fluids to be used for homogeneous immersion.

Mr. Krutschnitt's (New Orleans) six slides, four of which were sections of the ovaries of plants, were exhibited in support of the author's view of the fertilization of the ovule.

In the letter accompanying them, the writer said "the sections of the ovaries may go to show that the theory of the fertilization of the vegetable ovule by means of the pollen-tubes requires overhauling. See Amer. Mon. Micr. Journ., June 1882."

Dr. Maddox exhibited photographs of microscopical objects, printed by the platinotype process, which he found very suitable for scientific work, the paper being of fine texture, and capable of giving minute detail. (See Brit. Journ. of Photography, Sept. 15th, 1882.)

He also exhibited and described some new forms of warm and moist stages, which he exhibited in the room, and further explained by means of diagrams.

The President said that the stages were very simple, and very easily used, and would doubtless be of great use in examining blood and other objects, which it was desired to keep at an even, warm temperature.

Mr. J. W. Groves exhibited and described his improved ether-freezing microtome (see p. 755).

Mr. Stewart said that his own experience was that the ether method of freezing was a great advantage, for the full range of temperature was at command. It was only necessary to take care that the freezing was not overdone, so as to make the subjects brittle. A little practice enabled a person to control the temperature at will.

Mr. Kitton's note was read describing the results of his examination of the diatom material, sent by Mr. W. F. Petterd from Tasmania, which contained several interesting forms, but no new genera or species.

Mr. T. B. Rosseter's paper "Researches on the Life-history of *Stephanoceros Eichornii*," was read, and illustrated by drawings enlarged on the black-board.

Mr. Crisp said that the author of the paper was worthy of every possible encouragement and commendation, as his observations were

carried on under the greatest difficulties, and much credit was due to him for the indefatigable way in which he pursued them.

The President thought the paper was a very admirable one, whatever difference of opinion there might be as to some of the points touched upon.

Mr. T. C. White said that he was under the impression that as far as the attachment of the ovum to the parent was concerned, it was really attached to the case. The gelatinous envelope could hardly be called a case in the sense of being a thin structure, but it was rather a thick tube with solid walls, and when the creature retracted itself, the portion of the tube to which the ovum was attached was carried down with it. As regarded the viviparous character mentioned, he had observed it in *Rotifer vulgaris*, and had also noticed the fact that the parent died as Mr. Rosseter described.

Mr. Badcock having had an opportunity of previously reading the paper, read some critical remarks which he had written as to the question of the tube being "solid" or not.

Mr. Beck thought that the paper was an exceedingly interesting one, and after the remarks which had been made by Mr. Crisp as to the circumstances under which the observations had been made, it was doubly interesting. The way in which the writer had combined observation with experiment, and the manner in which he described the results, was, he thought, very creditable indeed. The fact of the creature making its way out of the cell, not at the top but at the lower end, was very interesting, for it would be natural to suppose that if any injury had taken place it would have escaped in the opposite direction. It occurred to him that this circumstance might afford a clue as to the way in which these objects expanded.

Mr. Michael thought that to a certain extent the question of an attachment to the tube was a substantial one, but whether the case was solid or tubular was more a matter of words. Pritchard could not mean that a cylinder in which a creature moved up and down was really "solid"; what he meant was probably that, instead of being a mere thin shell, it had a considerable thickness approaching towards solidity. The dragging down of the ovum, he thought, commenced before the arms touched the tube.

The President said it appeared to be quite clear that the tube had a considerable thickness, and that the attachment or adhesion to it was by the base only. With regard to the curious twisting round of the animal to get out at the lower end, it should be remembered that these creatures were *Vermes*, and that this was just the kind of thing a worm would do under the circumstances. He quite agreed with Mr. Beck in his remarks on the paper, and he hoped they would have more of the same kind.

Mr. Crisp made some remarks on the criticisms that had been passed on the paper.

Dr. Maddox read a paper on "Some Organisms found in the Excrement of the domestic Goat and the Goose" (see p. 749).

Mr. Geldart, the President of the Norfolk and Norwich Naturalists' Society, one of the *ex-officio* Fellows of the Society, was welcomed by the President.

Mr. Geldart said he was greatly obliged to the Fellows for the welcome given to him, and could only express the gratification which it afforded him to be present. He also wished to take advantage of the opportunity to thank them, in the name of his Society, for the privilege afforded to them of receiving the Journal of the Society, and profiting by the very admirable summary which it contained of all that was being done in microscopy, both at home and abroad.

Mr. Geldart then called attention to a slide of *Globigerina* which he had brought, with all its spines *in situ*—so unusual an object that it seemed to be worth bringing for exhibition. It was obtained by the 'Challenger.'

The President inquired whether it came from the surface.

Mr. Geldart said that this, and, indeed, all those, few in number, which had been obtained, came from the surface. Those brought up from the floor had the spines dragged off by the towing net. He had never seen more than two.

The President said that in examining some deposits from 14,000 feet he found them crammed with *Globigerinæ*, amongst which he had the good fortune to find one with spines. He was very glad to have seen this specimen as being an original from the 'Challenger' expedition.

The Conversazione was announced for the 6th December.

The following Instruments, Objects, &c., were exhibited:—

Mr. C. Collins:—Portable Histological Microscope.

Mr. Crisp:—(1) Guillemare's School Microscope. (2) Abbe's Refractometer.

Mr. Curties:—Simple and Dissecting Microscopes by Zeiss.

Mr. Geldart:—*Globigerinæ* from the 'Challenger.'

Mr. Groves:—New Ether-freezing Microtome.

Mr. Joshua:—*Triploceras tridentatum* (New Zealand Desmid).

Mr. Kitton:—Five slides of Diatoms from Tasmania.

Mr. Krutschnitt:—Six slides of ovaries, &c., of plants.

Dr. Maddox:—(1) Photographs printed by the platinotype process. (2) Warm and Moist Stages.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Joseph Ball, Cornelius Van Brunt, Walter A. Dun, George E. Fell, James D. Hardy, David Houston, William A. Lee, Clermont Livingston, George M. Sternberg, and Frederick A. Whaite.

WALTER W. REEVES,
Assist.-Secretary.

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*** The Index includes the names of the Authors of all Papers, &c., printed in the "Transactions" or noted in the "Summary," as well as those of the Designers of any Instruments and Apparatus described under the head of "Microscopy."

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